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Katayama

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(54) **MANUALLY PROPELLED VEHICLE**

(71) Applicant: **Funai Electric Co., Ltd.**, Osaka (JP)

(72) Inventor: **Takahiro Katayama**, Osaka (JP)

(73) Assignee: **Funai Electric Co., Ltd.**, Osaka (JP)

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(51) **Int. Cl.**

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B60L 3/00	(2006.01)
B60L 15/20	(2006.01)
A61H 3/04	(2006.01)
B62B 5/00	(2006.01)

(52) **U.S. Cl.**

CPC ***B60L 3/0015*** (2013.01); ***A61H 3/04*** (2013.01); ***B60L 15/2036*** (2013.01); ***B62B 5/0069*** (2013.01); *A61H 2003/043* (2013.01); *A61H 2201/0176* (2013.01); *A61H 2201/5064* (2013.01)

(58) **Field of Classification Search**

CPC B60L 3/0015; B60L 15/2036; A61H 3/04; A61H 2003/043; A61H 2201/0176; A61H 2201/5064

USPC 701/22; 180/6.66

See application file for complete search history.

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Primary Examiner — Luke Huynh

(74) *Attorney, Agent, or Firm* — Osha Liang LLP

(57) **ABSTRACT**

A manually propelled vehicle may include a vehicle body, a left drive wheel and a right drive wheel, a wheel driver that drives the left and right drive wheels, a sensor that detects a user behind the vehicle body, and a controller that determines whether the user is behind the left or right drive wheel based on a detected result of the sensor. When one of the left or right drive wheel moves backward and the controller detects that the user is behind the one of the left or right drive wheel, the controller suppresses or stops the wheel driver from driving the one of the left or right drive wheel.

16 Claims, 16 Drawing Sheets

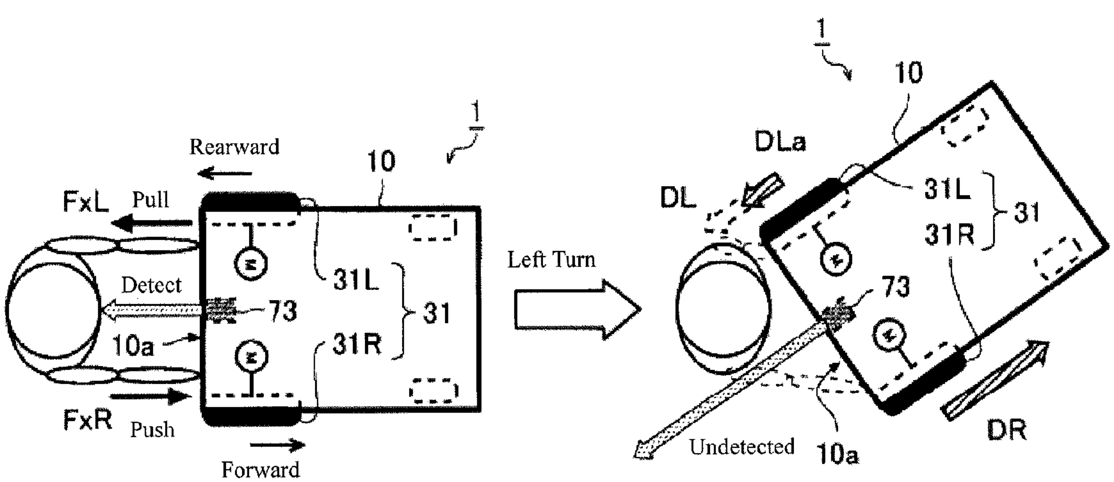
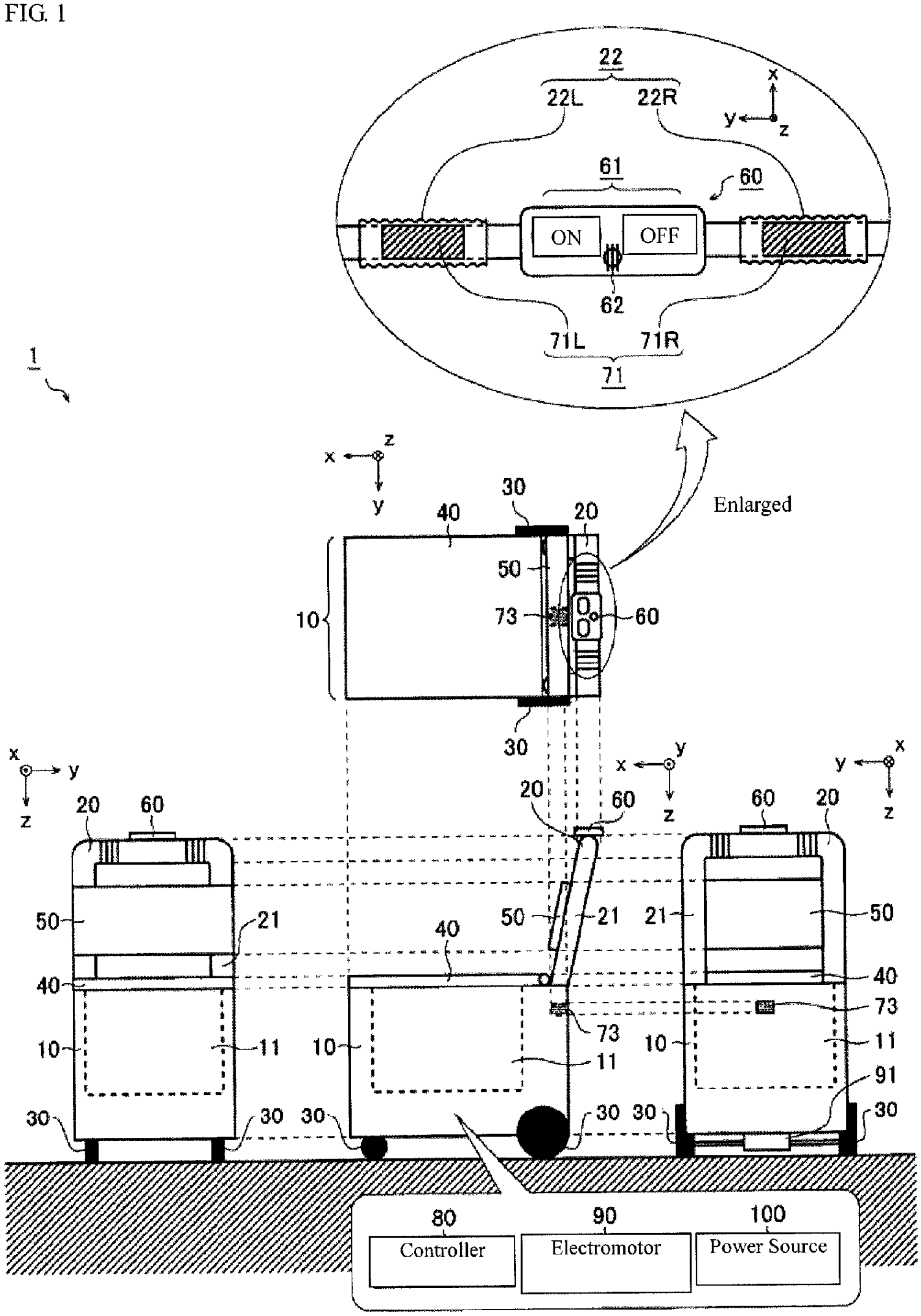


FIG. 1



22
22L
22R
61
60
ON
OFF
62
71L
71R
71
1
Enlarged
30
40
20
50
10
73
60
30
20
60
50
21
40
10
11
30
80
Controller
90
Electromotor
100
Power Source
73
91

FIG. 2

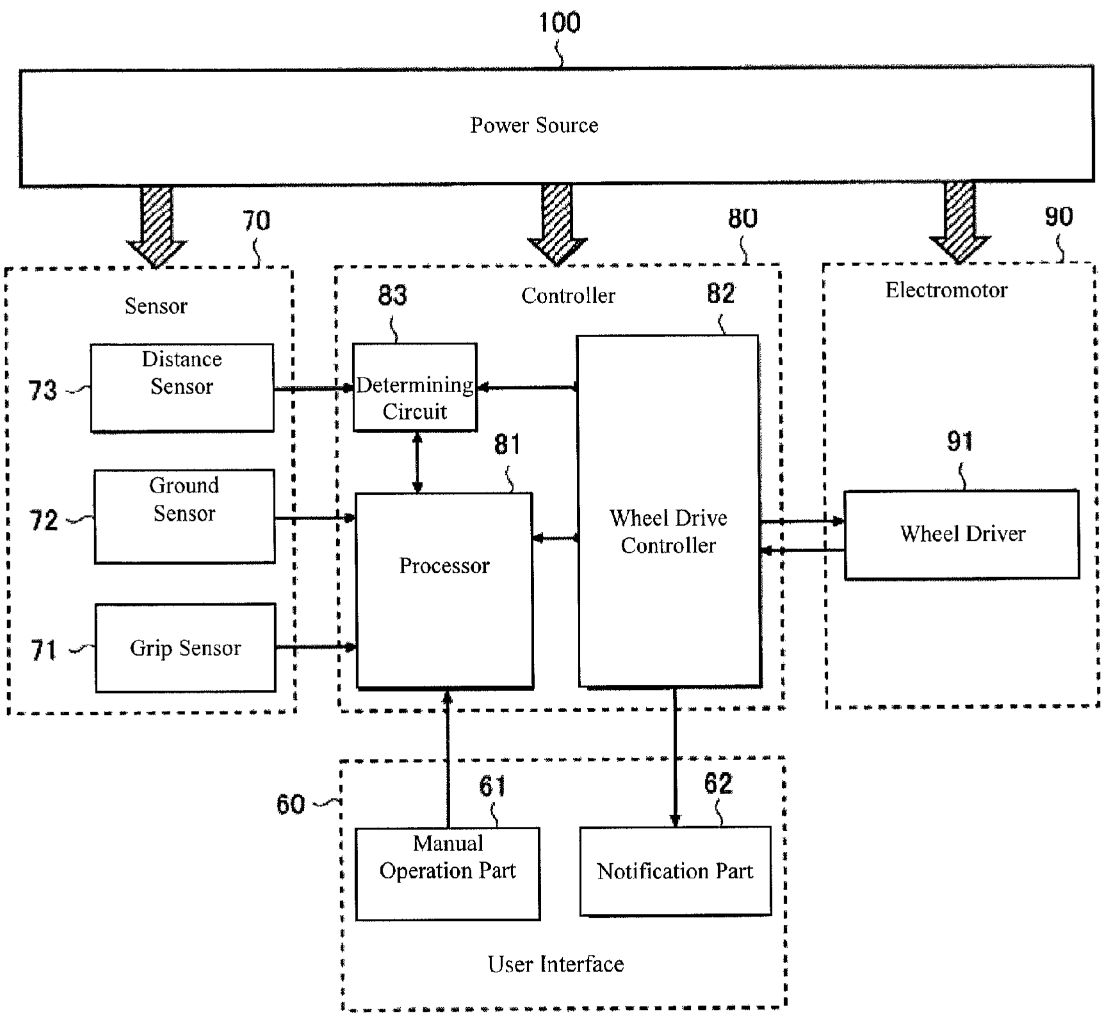

100
Power Source
70
80
90
Sensor
83
Controller
82
Electromotor
Distance Sensor
73
Determining Circuit
81
91
Ground Sensor
72
Wheel Drive Controller
Wheel Driver
Processor
Grip Sensor
71
60
61
62
Manual Operation Part
Notification Part
User Interface

FIG. 3

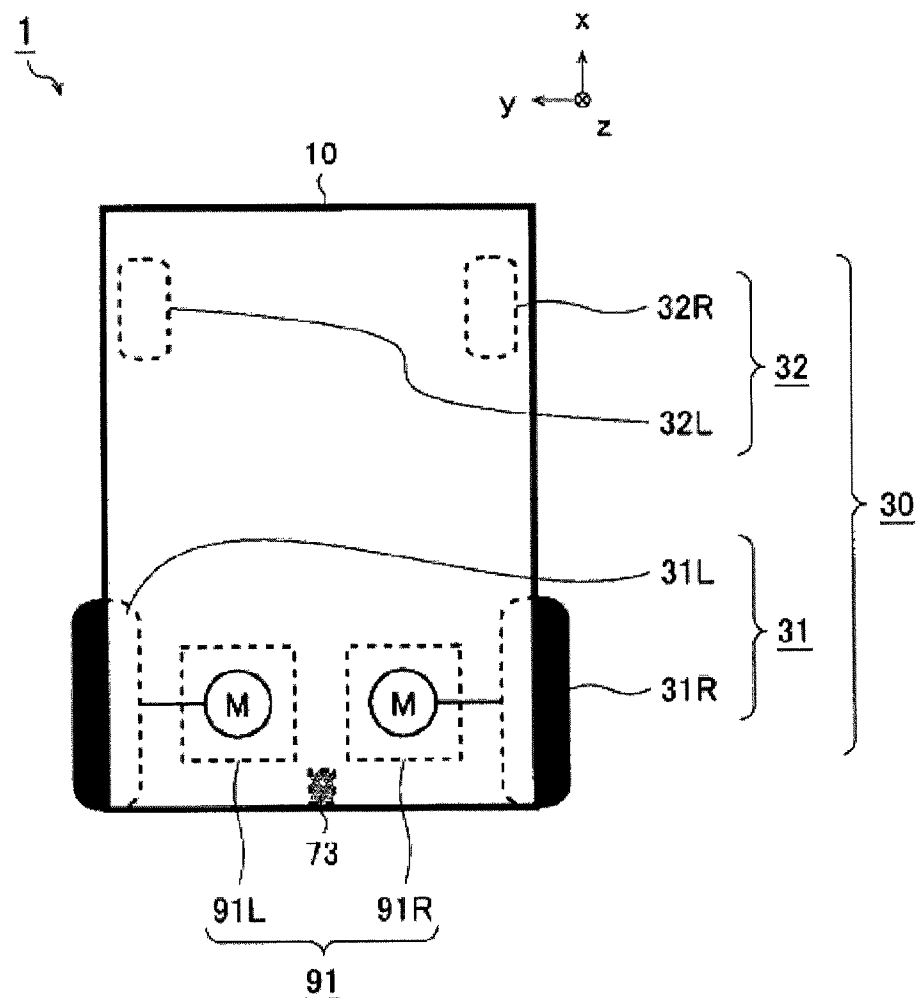


FIG. 4

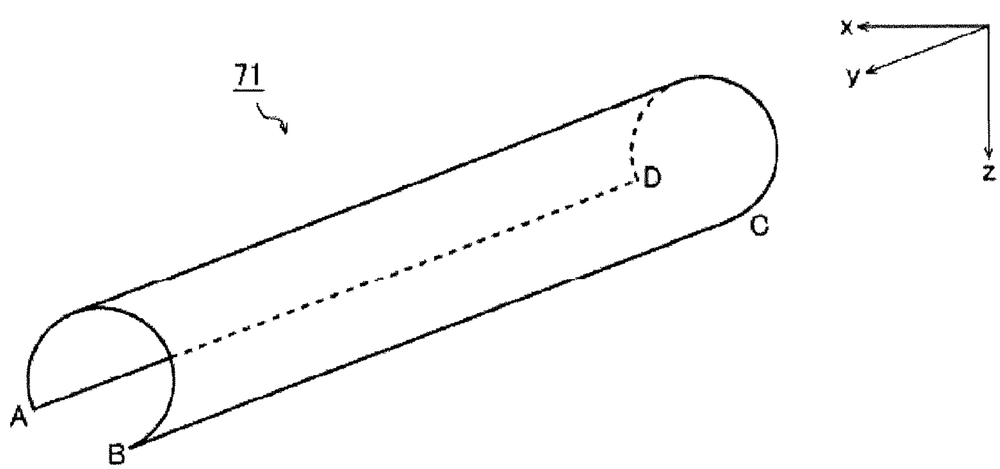


FIG. 5

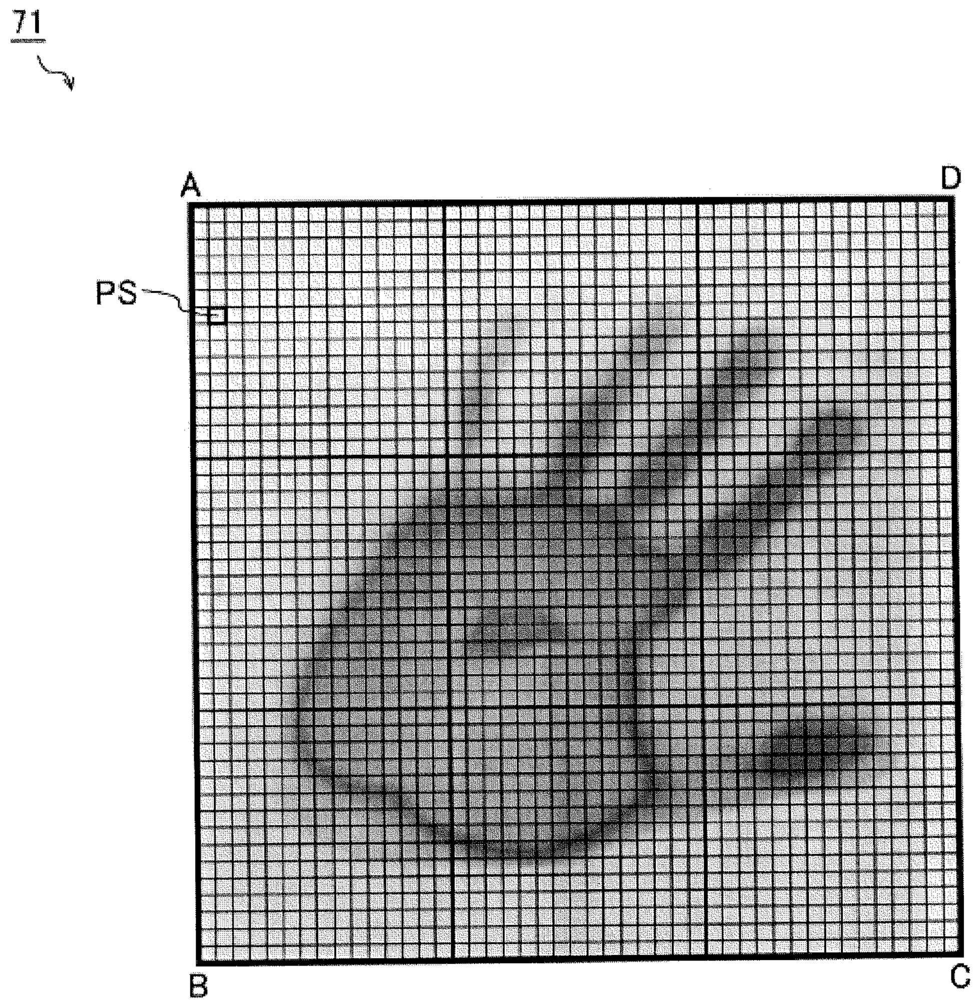


FIG. 6

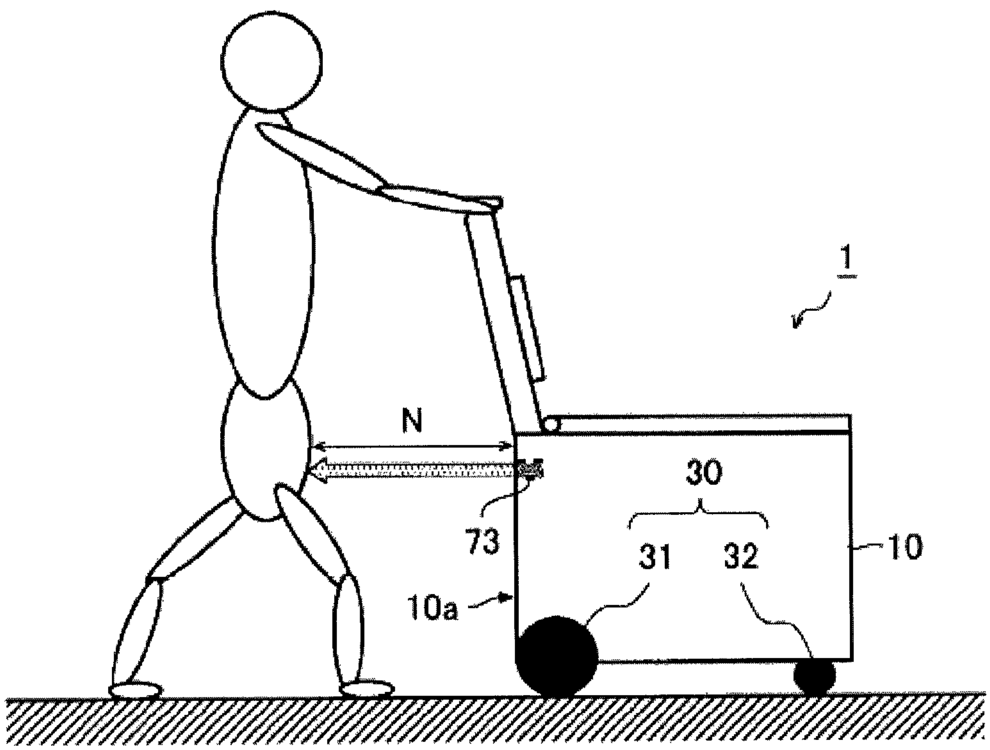
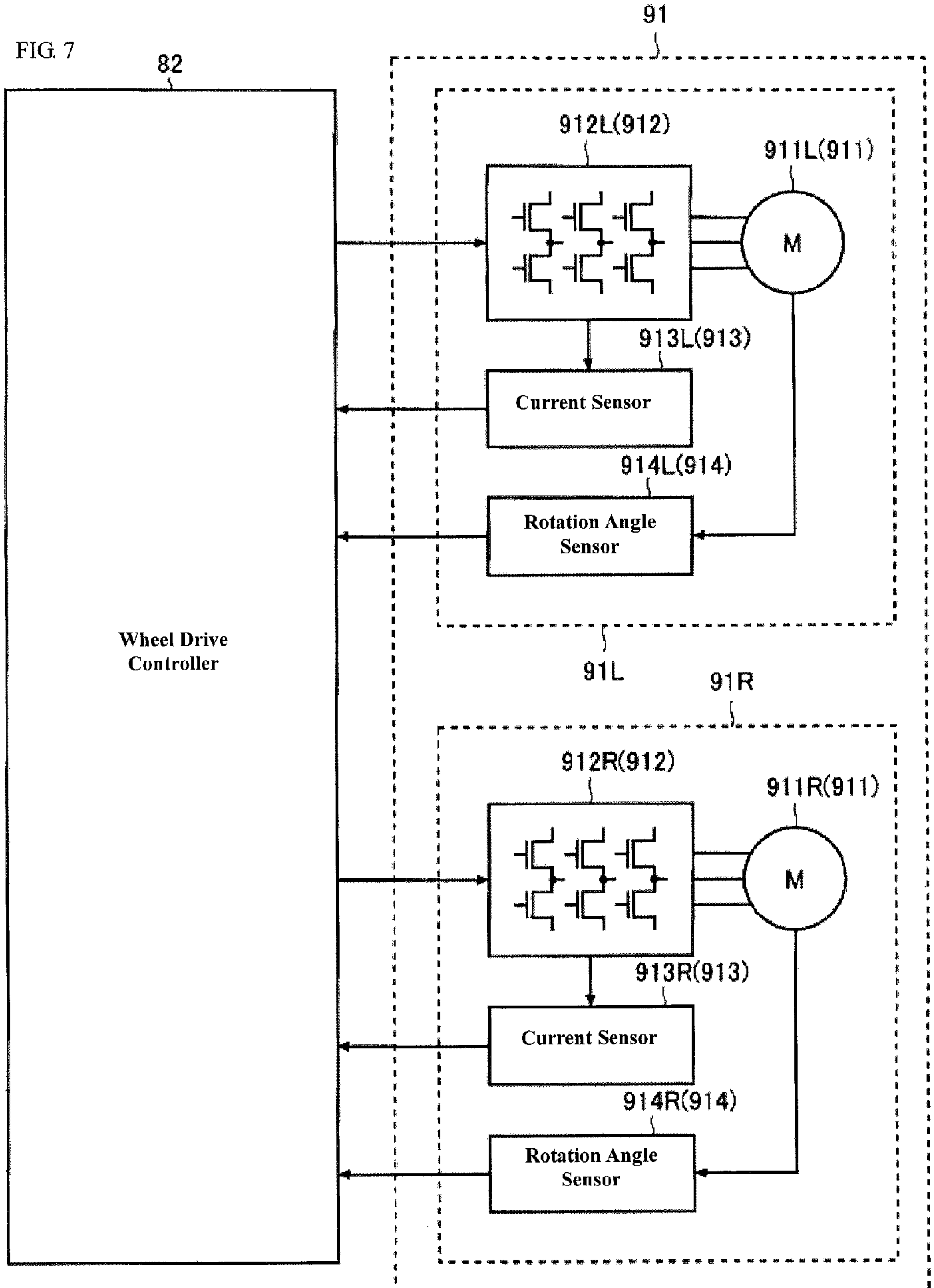


FIG. 7



82
91
912L(912)
911L(911)
M
913L(913)
Current Sensor
914L(914)
Rotation Angle Sensor
Wheel Drive Controller
91L
91R
912R(912)
911R(911)
M
913R(913)
Current Sensor
914R(914)
Rotation Angle Sensor

FIG. 8

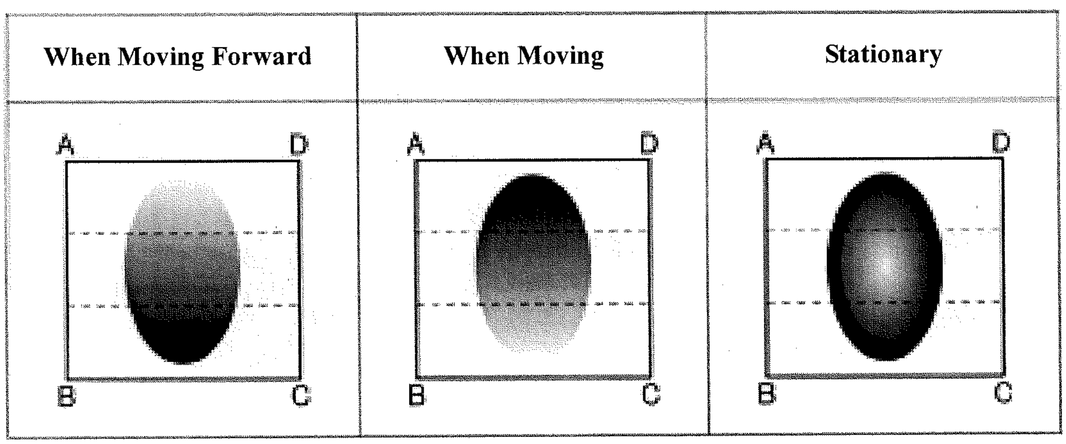


FIG. 9

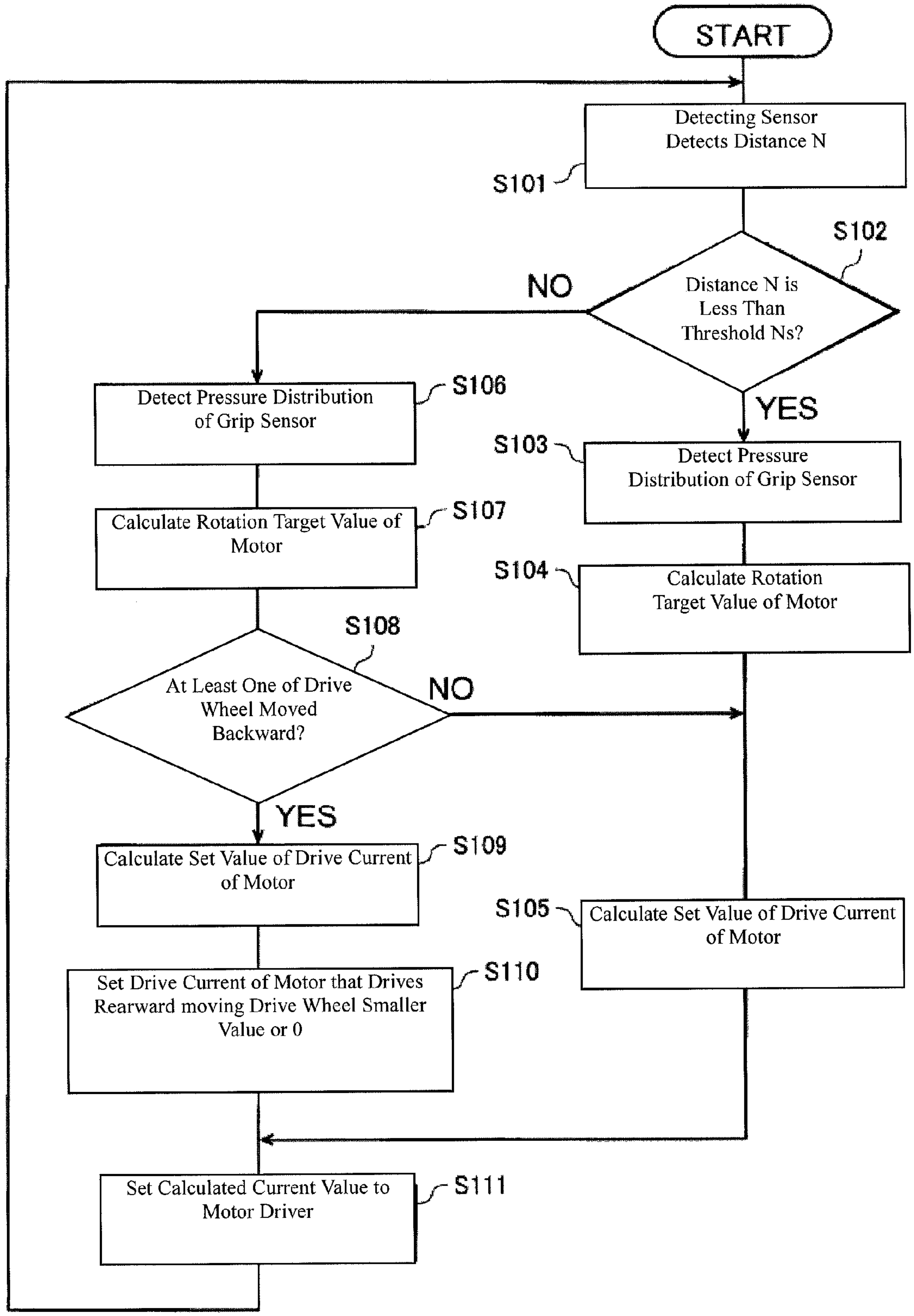
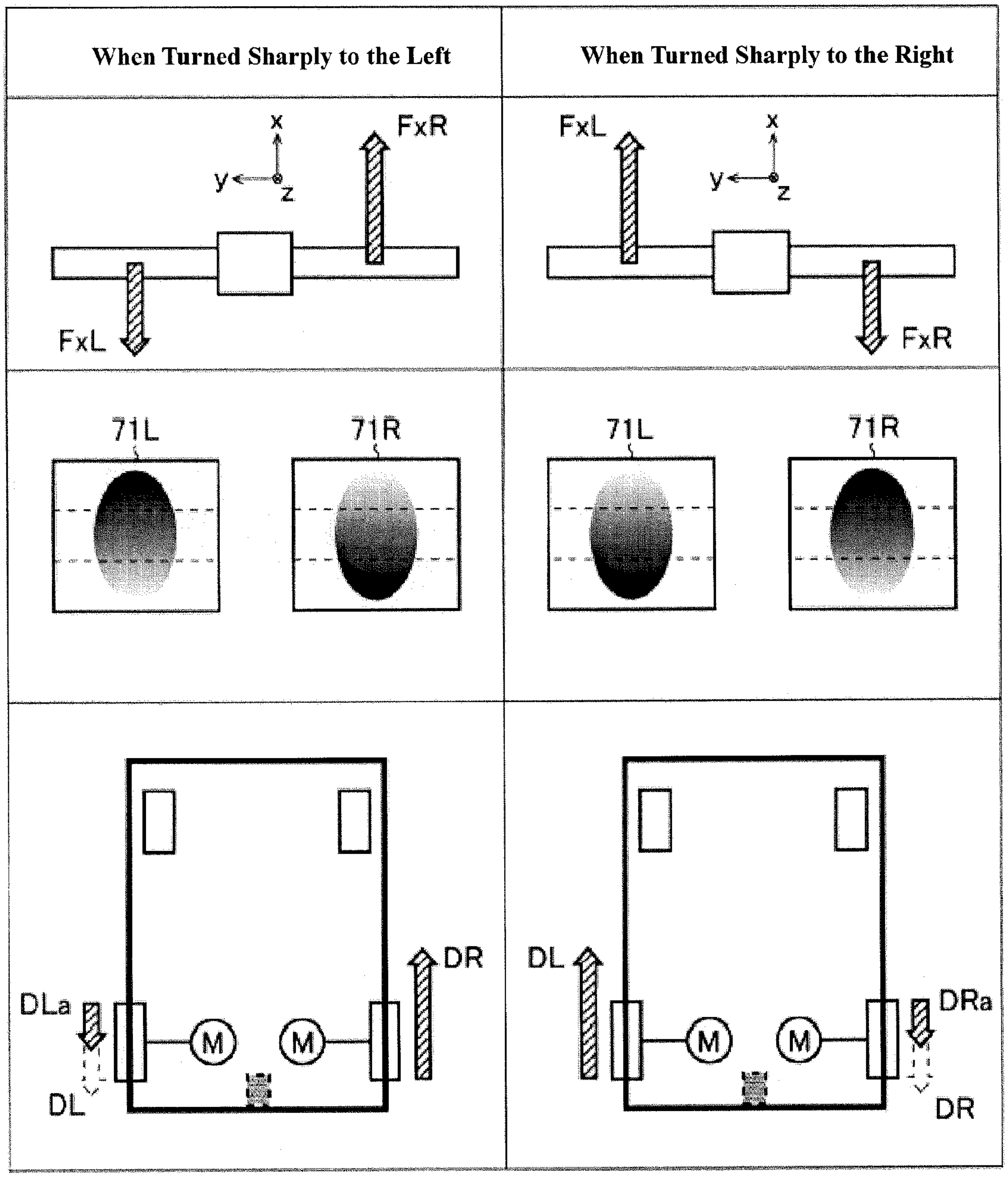

START
Detecting Sensor Detects Distance N
S101
S102
Distance N is Less Than Threshold Ns?
NO
YES
Detect Pressure Distribution of Grip Sensor
S106
S103
Detect Pressure Distribution of Grip Sensor
Calculate Rotation Target Value of Motor
S107
S104
Calculate Rotation Target Value of Motor
S108
At Least One of Drive Wheel Moved Backward?
NO
YES
Calculate Set Value of Drive Current of Motor
S109
S105
Calculate Set Value of Drive Current of Motor
Set Drive Current of Motor that Drives Rearward moving Drive Wheel Smaller Value or 0
S110
Set Calculated Current Value to Motor Driver
S111

FIG. 10



When Turned Sharply to the Left
When Turned Sharply to the Right
x
y
z
FxR
FxL
71L
71R
M
DLa
DL
DR
DRa

FIG. 11

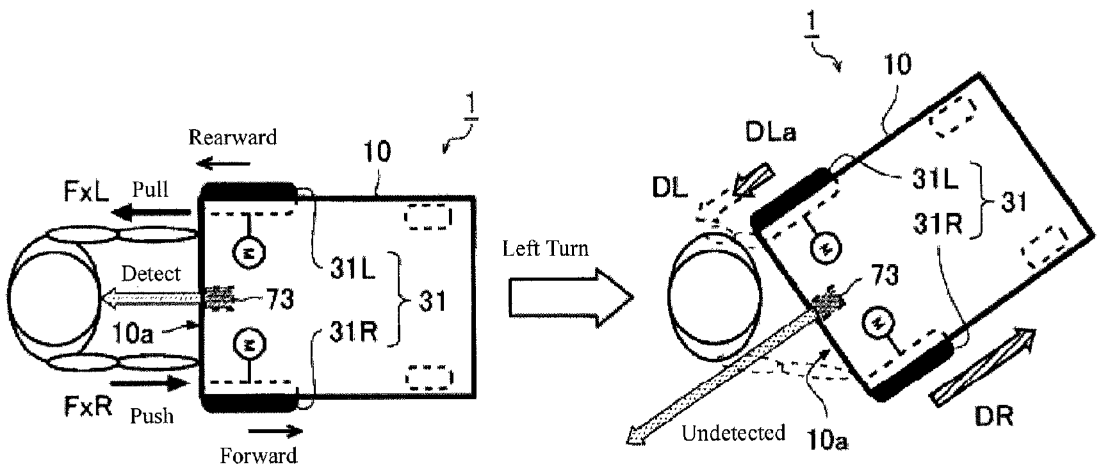

Rearward
10
1
FxL
Pull
Detect
73
10a
31L
31
31R
FxR
Push
Forward
Left Turn
1
10
DLa
DL
31L
31R
31
73
Undetected
10a
DR

FIG. 12

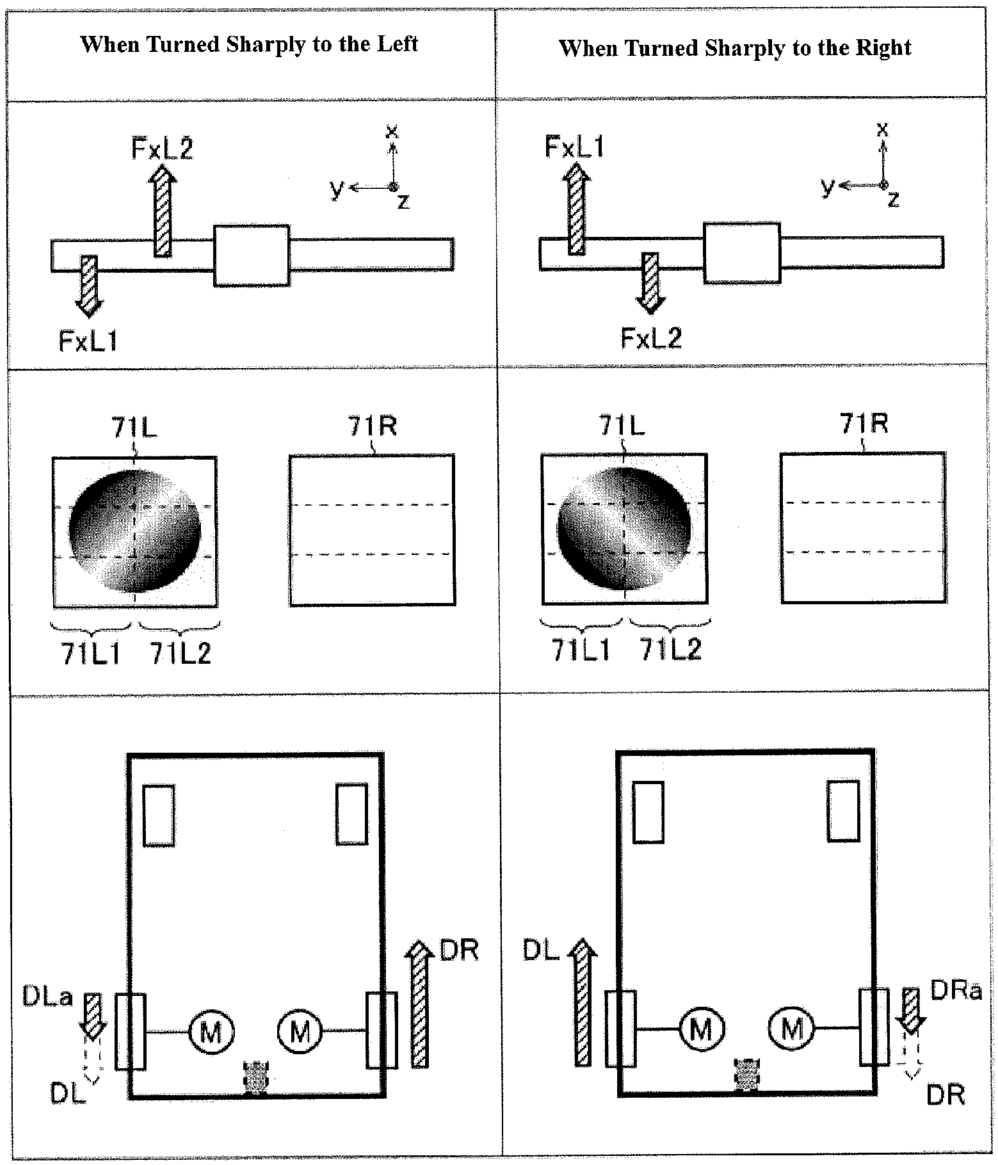

When Turned Sharply to the Left
When Turned Sharply to the Right
FxL2
FxL1
x
y
z
FxL1
FxL2
71L
71R
71L1
71L2
71L
71R
71L1
71L2
DR
DLa
DL
M
M
DL
DRa
DR
M
M

FIG. 13

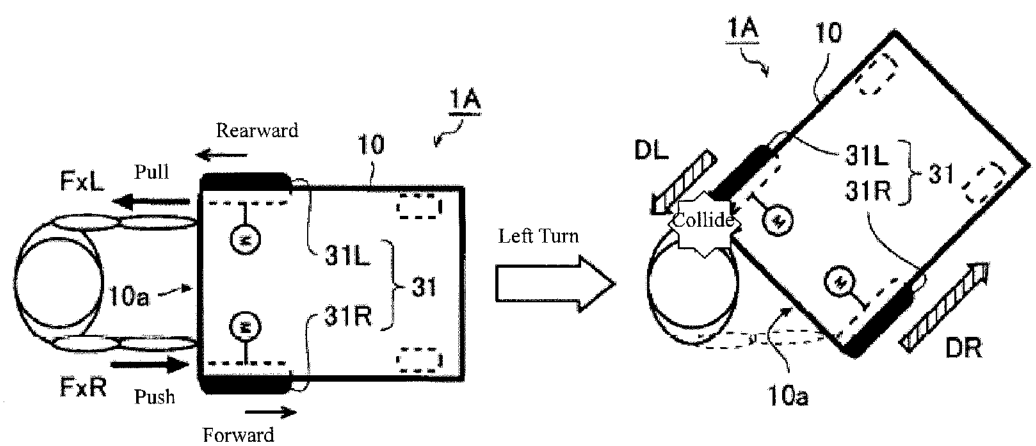

Rearward
Pull
FxL
10
1A
10a
31L
31
31R
FxR
Push
Forward
Left Turn
1A
10
DL
31L
31R
31
Collide
DR
10a

FIG. 14

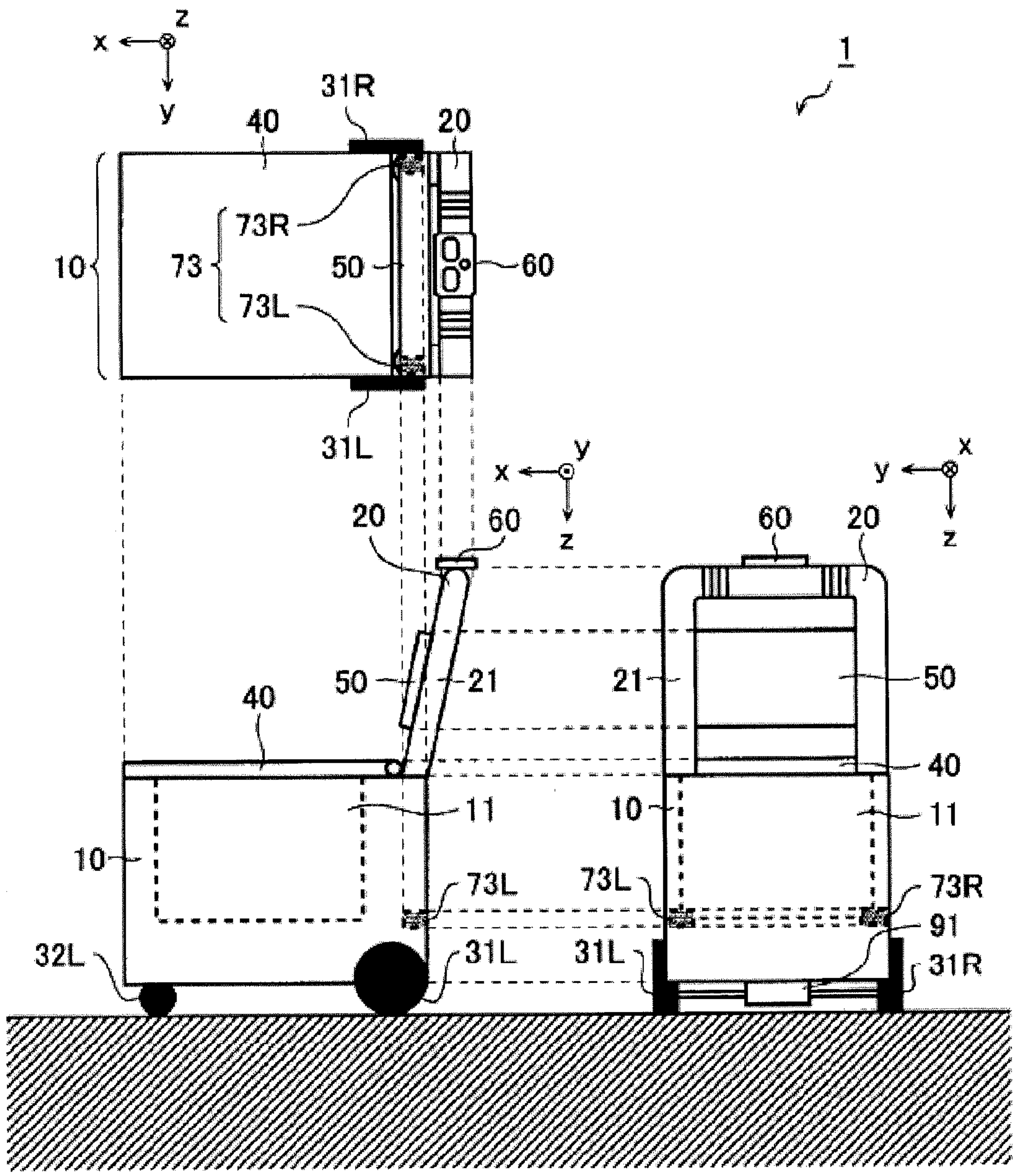


FIG. 15

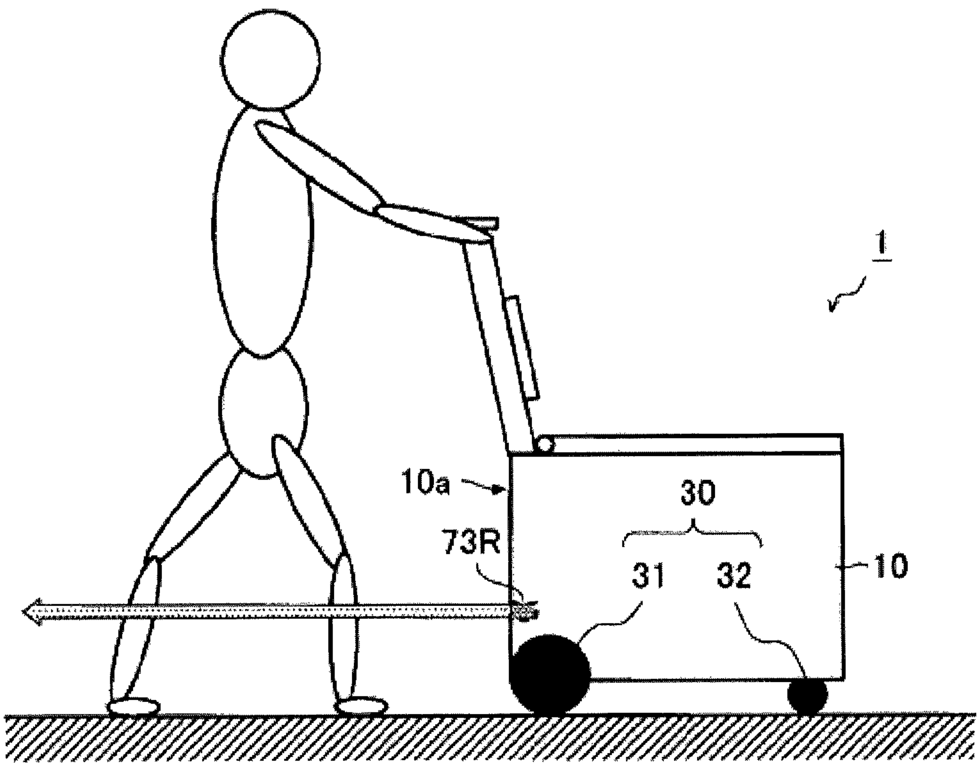


FIG. 16

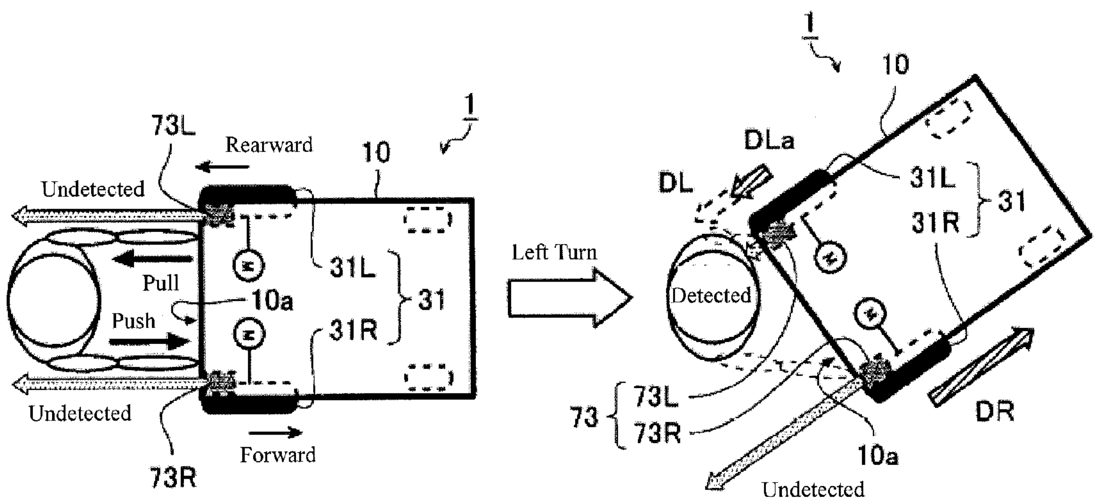
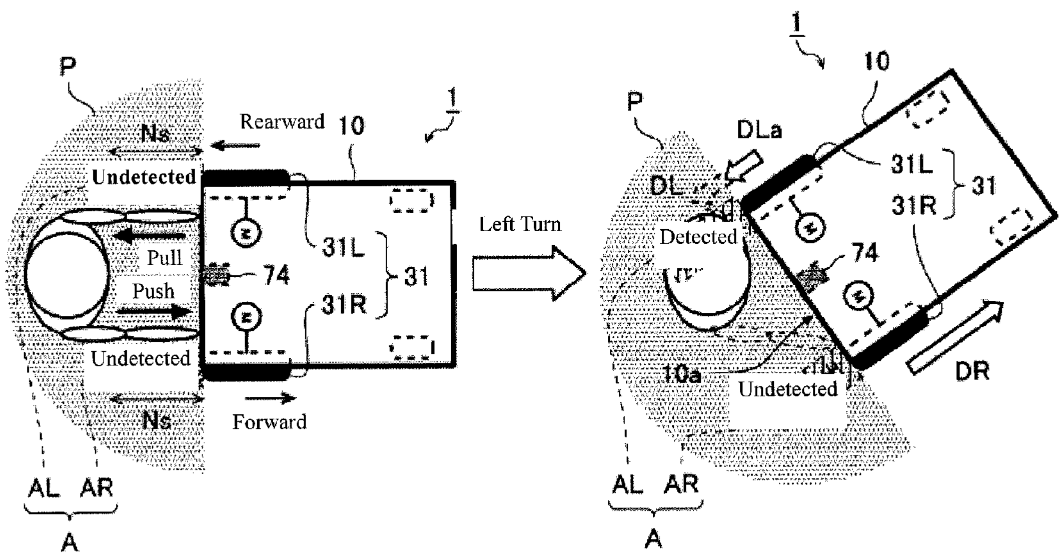

73L
Rearward
10
1
Undetected
Pull
10a
31L
31
Push
31R
Undetected
73R
Forward
Left Turn
1
10
DLa
DL
31L
31R
31
Detected
73
73L
73R
10a
DR
Undetected

FIG. 17


P
Ns
Rearward
10
1
Undetected
Pull
Push
74
31L
31R
31
Undetected
Ns
Forward
AL
AR
A
Left Turn
1
10
P
DLa
DL
31L
31R
31
Detected
74
10a
Undetected
DR
AL
AR
A

MANUALLY PROPELLED VEHICLE

TECHNICAL FIELD

The field of the invention relates to a manually propelled vehicle (e.g., ambulatory assist vehicles, baby carriages, dollies, wheelchairs, and the like).

RELATED ART

Conventional manually propelled vehicles are configured so as to change direction freely according to the difference of the external force applied to right and left grips. Further, in recent years, development of mobile assistance tools for going out have advanced with the application of robotic technologies such as sensors and actuators, and the mounting of human-power assist functions (so-called motor assisted functions) onto manually propelled vehicles (e.g., ambulatory assist vehicles to support elderly or people with trouble walking to go out) are being studied.

In common manually propelled vehicles, a user moves forward by pushing the manually propelled vehicle from the rear. At that time, in order to assist walking by the user, the manually propelled vehicle provides torque to a drive wheel according to an amount of force to push the manually propelled vehicle by the user. A burden on the user is reduced by such assisting operation.

As an example of conventional art relevant to the present invention, Patent Document 1 discloses an ambulatory assist vehicle that operates according to a mobility assisting operation that is set in advance when moving forward, moving backward, and turning.

DOCUMENTS OF THE RELATED ART

PATENT DOCUMENT

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2898969

However, when turning a manually propelled vehicle to the right or left, even though an outer wheel moves forward, there may be a case where an inner wheel moves backward. For example, in a conventional manually propelled vehicle that is equipped with an electromotor assist function, the rear wheel is often the drive wheel and the front wheel is the idler wheel, and the inner wheel side of the drive wheel is easy to move backward during a turning motion. In such case, if a user is familiar with the operation of the manually propelled vehicle, a collision with the manually propelled vehicle can be avoided by moving in accordance with the turning operation of the manually propelled vehicle. On the other hand, when a user is not familiar with it, the user often cannot correspond to the operation of the manually propelled vehicle. Further, the manually propelled vehicle that is equipped with the electromotor assist function as described above performs drive assistance by providing torque to the drive wheel in order to assist walking of the user. Therefore, there is a risk where the user may collide harder than that of the manually propelled vehicle that is not equipped with the electromotor assist function, and furthermore, a foot of the user may contact the drive wheel that is moving backwards.

The conventional art of Patent Document 1 does not mention these problems, and it is necessary to readjust the settings in advance of the mobility assisting operation of the ambulatory assist vehicle according to the skill level of the user.

SUMMARY OF THE INVENTION

One or more embodiments of the invention provide a manually propelled vehicle that can buffer or prevent a collision with a user during a turning motion.

According to one or more embodiments, a manually propelled vehicle may comprise: a vehicle body; a left drive wheel and a right drive wheel; a wheel driver that drives the left and right drive wheels; a sensor that detects a user behind the vehicle body; and a controller that determines whether the user is behind the left or right drive wheel based on a detected result of the sensor, wherein when one of the left or right drive wheel moves backward and the controller detects that the user is behind the one of the left or right drive wheel, the controller may suppress or stop the wheel driver from driving the one of the left or right drive wheel. By having such configuration, for example, even if one of the left or right drive wheels has moved rearward, when turning the manually propelled vehicle, the electromotor drive of one of the rearward moving left or right drive wheel may be suppressed or stopped when it is determined that there is the user behind the rearward moving drive wheel. According to one or more embodiments, when the manually propelled vehicle is turned, the manually propelled vehicle can buffer or prevent a collision with the user who is behind the manually propelled vehicle because the turning motion of the manually propelled vehicle can be braked or stopped.

According to one or more embodiments, the sensor may comprise a distance sensor provided between the left and right drive wheels and that detects whether the user is behind the vehicle body in an area that is not behind the left or right drive wheel when viewed from vertically above in a planar view, the distance sensor may output a distance to an object located behind the distance sensor, and when the one of the left or right drive wheel moves backward and the distance output by the distance sensor is greater than or equal to a threshold, the controller may suppress or stop the wheel driver from driving the one of the left or right drive wheel. By having such configuration, for example, when turning the manually propelled vehicle, the distance sensor provided between the left and right drive wheels may detect whether or not the user is behind the vehicle body part except behind the left and right drive wheels. Further, for example, if the distance outputted by the distance sensor is not less than the distance threshold, it may be estimated that the user is behind one of the drive wheels. Then, for example, the electromotor drive of that side that is the rearward moving drive wheel may be suppressed or stopped. According to one or more embodiments, a collision between the user and the manually propelled vehicle can be buffered or prevented by the distance sensor provided between the left and right drive wheels.

According to one or more embodiments, the sensor may comprise a distance sensor provided respectively above the left and right drive wheels, each of the distance sensors respectively may output a distance to an object located behind the distance sensor, and when the one of the left or right drive wheel moves backward and the distance output by the distance sensor provided above the one of the left or right drive wheel is less than a threshold, the controller may suppress or stop the wheel driver from driving the one of the left or right drive wheel. By having such configuration, for example, when turning the manually propelled vehicle, if the distance outputted by the distance sensor above the side which has a rearward moving drive wheel is less than the threshold, it may be determined that the user is behind the side which has a rearward moving drive wheel. Then, the electromotor drive of that side that is the rearward moving drive wheel may be suppressed or stopped. According to one or more embodiments, a collision between the user and the manually propelled vehicle can be buffered or prevented by the distance sensor provided respectively above the left and right drive wheels.

According to one or more embodiments, the sensor may comprise a range sensor that detects a location of the user by scanning behind the vehicle body. By having such configuration, for example, the location of the user behind the vehicle body part may be detected by the range sensor. According to one or more embodiments, the manually propelled vehicle can determine accurately whether or not the user is behind the left or right drive wheel (e.g., one side that is the rearward moving drive wheel) based on the detected position of the user.

According to one or more embodiments, the sensor detect whether a leg of the user is behind the left or right drive wheel. By having such configuration, for example, contact between the leg of the user and the wheel of that side having a rearward moving drive wheel can be prevented, or an impact at the time of contact can be buffered.

One or more embodiments of the present invention can provide a method for controlling a manually propelled vehicle comprising a vehicle body, a left drive wheel and a right drive wheel that are driven and controlled independently to move the vehicle body along with a walking user, and a wheel driver that drives the left and right drive wheels. The method may comprise: detecting the user behind the vehicle body; determining whether the user is behind the left or right drive wheel based on the detecting; and when one side of the left or right drive wheel moves backward and the determining determines that the user is behind the one side of the left or right drive, suppressing or stopping the wheel driver from driving the one of the left or right drive wheel.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an external view of an manually propelled vehicle **1** according to one or more embodiments of a first example;

FIG. **2** is a functional block diagram of the manually propelled vehicle **1** according to one or more embodiments of the first example;

FIG. **3** is a schematic diagram illustrating an example of one configuration of a wheel and a wheel driver according to one or more embodiments;

FIG. **4** is a perspective view illustrating an example of one configuration of a grip sensor according to one or more embodiments;

FIG. **5** is a plan expansion view illustrating an example of one configuration of the grip sensor according to one or more embodiments;

FIG. **6** is a side view illustrating a location of a distance sensor in one or more embodiments of the first example;

FIG. **7** is a functional block diagram illustrating an example of one configuration of the wheel driver according to one or more embodiments;

FIG. **8** is an illustration of a pressure distribution of the grip sensor when moving by manual operation (when moving forward, moving backward, or braking) according to one or more embodiments;

FIG. **9** is a flowchart to describe an operation of a turning assist function of the manually propelled vehicle **1** according to one or more embodiments;

FIG. **10** is an explanatory diagram of the turning assist function when the manually propelled vehicle **1** is turned sharply operated with both hands according to one or more embodiments;

FIG. **11** is an explanatory diagram of the turning operation when the manually propelled vehicle **1** in one or more embodiments of the first example is turned sharply operated with both hands;

FIG. **12** is an explanatory diagram of the turning assist function when the manually propelled vehicle **1** in one or more embodiments of the first example is turned sharply operated with one hand;

FIG. **13** is an explanatory diagram of a turning operation when the manually propelled vehicle **1** that is not equipped with the distance sensor is turned sharply operated with both hands according to one or more embodiments;

FIG. **14** is an external view of an manually propelled vehicle **1** according to one or more embodiments of a second example;

FIG. **15** is a side view illustrating a location of a distance sensor in one or more embodiments of the second example;

FIG. **16** is an explanatory diagram of the turning operation when the manually propelled vehicle **1** in one or more embodiments of the second example is turned sharply operated with both hands; and

FIG. **17** is an explanatory diagram of the turning operation when the manually propelled vehicle **1** in one or more embodiments of a third example is turned sharply operated with both hands.

DETAILED DESCRIPTION OF EMBODIMENTS

FIRST EXAMPLE

FIG. **1** and FIG. **2** respectively illustrate an external view and a functional block diagram of an manually propelled vehicle **1** according to one or more embodiments of a first example. The lower part of FIG. **1** schematically illustrates from left to right on the sheet in order, a front view (front elevation), a left lateral view, and a posterior view (back elevation) of the manually propelled vehicle **1**, and the middle center part of FIG. **1** illustrates a top view of the manually propelled vehicle **1**. Further, the upper part of FIG. **1** illustrates an enlarged view of the handle part, schematically.

The manually propelled vehicle **1** may be a so-called walker to assist walking of a user (e.g., elderly with a weak lower body) and may also be used as a basket for carrying baggage and a seat for resting. The manually propelled vehicle **1** may comprise a vehicle body **10**, a grip **20**, a wheel **30**, a seat **40**, a backrest **50**, a user interface **60**, a sensor **70**, a controller **80**, an electromotor **90**, and a power source **100**.

The vehicle body **10** may be a chassis (frame) of the manually propelled vehicle **1** on which the configuration elements **20** to **100** listed above are mounted. Further, a space as a baggage compartment **11** may be provided inside (lower part of the seat **40**) the vehicle body **10**. Stainless steel, aluminum alloy, or the like may be used for the frame material faulting the vehicle body **10**.

The grip **20** may be member where the user grips at the time of walking and connected to the vehicle body **10** via a support part **21**. The user can move the manually propelled vehicle **1** forward, backward, braking, and turning by applying human power through gripping the grip **20** with both hands or with one hand. In addition, the grip **20** may comprise a slip resistance grip **22** (left hand grip **22**L and right hand grip **22**R). Further, a height adjustment mechanism may be provided to the grip **20** or the support part **21**.

The wheel **30** may be an annular member in order to move the vehicle body **10** along the ground by rotating in harmony with the walking of the user. FIG. **3** is a schematic diagram illustrating an example of one configuration of the wheel **30** and a wheel driver **91**. As illustrated in FIG. **3**, the wheel **30** may be a four-wheel structure comprising drive wheels **31** (left and right drive wheels **31**L and **31**R) that are rotated at the axle center by human power (or auxiliary power) and idler wheels **32** (left and right coupled drive wheels **32**L and **32**R) for turning direction. The left and right drive wheels **31**L and **31**R may be driven and controlled independently by the rotation speed, rotation direction, and rotation torque respectively corresponding to each wheel driver **91**L and **91**R described below.

The seat **40** may be a plate-like member for the user to sit down on when seating. Further, the seat **40** may also function as an upper lid of the luggage compartment **11** and be attached so as to enable the upper opening part of the baggage compartment **11** to open and close.

The backrest **50** may be a plate-like member for the user to lean back against when seating. In addition, the backrest **50** may be attached to the support part **21** or integrally provided with the vehicle body **10**.

The user interface **60** may be means to exchange information between the user and the controller **80** and may include a manual operation part **61** and a notification part **62**. The manual operation part **61** may be means for receiving the manual operation of the user including, for example, an ON/OFF button on the electromotor assist function. The notification part **62** may be means for informing the user of various information. As the notification part **62**, a light emitting diode, a liquid crystal display panel, or the like may be used other than a speaker as illustrated. The user interface **60** may be provided at a position where the user can easily operate (for example, the grip **20** that is near the height of the eyes of the user.

The sensor **70** may be means for monitoring surrounding conditions, usage condition of the manually propelled vehicle **1**, or a walking posture of the user and a relative position to the manually propelled vehicle **1**. The sensor **70** may comprise a grip sensor **71** and a ground sensor **72**, and a distance sensor **73**. The grip sensor **71** may be means for monitoring a distribution of pressure applied to the grip **20**, and may comprise a left hand grip sensor **71**L provided at the left hand grip **22**L and a right hand grip sensor **71**R provided at the right hand grip **22**R.

Each of FIG. **4** and FIG. **5** is a perspective view and a plan expansion view illustrating an example of one configuration of the grip sensor **71**. Reference numerals A to D correspond to four corners of the grip sensor **71** illustrated in both drawings. The grip sensor **71** may be a sheet-like member where a plurality of pressure sensors PS is arranged in a matrix and used by winding around the grip **20**. The plurality of pressure sensors PS may output an electric signal in which the signal level (for example, a voltage value) fluctuates according to the amount of pressure applied to each. Accordingly, when the user is holding the grip **20**, a distribution of pressure according to the gripping conditions may be detected by the grip sensor **71**. The pressure distribution may be detected by both sides of the left hand grip sensor **71**L and the right hand grip sensor **71**R when being operated by both hands, and when being operated by one hand, either one side of the left hand grip sensor **71**L or the right hand grip sensor **71**R.

In the example of the present configuration, the left hand grip sensor **71**L and the right hand grip sensor **71**R are physically separated; however, the structure of the grip sensor **71** is not limited thereto. The sensor **71** may be formed integrally without separating the left hand grip sensor **71**L and the right hand grip sensor **71**R from each other. Or on the contrary, each of the left hand grip sensor **71**L and the right hand grip sensor **71**R may be further separated from each other.

A ground sensor **72** may respectively detect the grounded state of the drive wheel **31** and the idler wheel **32**. A load sensor of a suspension type provided between the vehicle body **10** and the wheel **30** may be used as the ground sensor **72**. The grounded state of the drive wheel **31** may also be presumed from the output of a current sensor **913** to be described later rather than providing the load sensor separately. For example, when the drive currents running to the left and right motors **911**L and **911**R to be described later are decreased steeply and fall below a predetermined threshold, it can be determined that the drive wheel **31** is an ungrounded state.

The distance sensor **73** may detect a user who is positioned rearward of the manually propelled vehicle **1** (vehicle body **30**). For example, the distance sensor **73** may be provided between the left and right drive wheels **31**L and **31**R in order to detect whether the user is rearward of the vehicle body **10** except behind the drive wheel **31** in a planar view viewed from vertically above. For the distance sensor **73**, for example, an infrared sensor, an ultrasonic sensor, or the like may be used. FIG. **6** is a side view illustrating a position of the distance sensor **73** according to one or more embodiments of the first example. As illustrated in FIG. **6**, the distance sensor **73** may be provided on the backside surface **10***a* of the vehicle body **10**, and outputs a distance N to an object (e.g. user) positioned rearward of the distance sensor **73**. Further, the distance sensor **74** may be disposed between the left and right drive wheels **31**L and **31**R in a planar view viewing the manually propelled vehicle **1** from vertically above (see FIG. **11** described below). Furthermore, the disposition position in the vertical direction of the distance sensor **73** is not particularly limited. The distance sensor **73** may be disposed, for example, in a position where the torso part of the user is detected, as illustrated in FIG. **6**, or in a position where the leg of the user is detected.

The controller **80** may be a logic circuit (such as a microcomputer) that comprehensively controls the user interface **60**, sensor **70**, and electromotor **90**. The controller **80** may comprise a processor **81**, a wheel drive controller **82**, and a determining circuit **83** as a functional block. The processor **81** may determine a turning target value (e.g., such as a target value of a driving direction and driving force of the left and right drive wheels **31**L and **31**R) according to the output of the grip sensor **71**. The wheel drive controller **82** may control the rotation direction and the rotation speed of the left and right drive wheels **32**L and **32**R according to the turning target value. The determining circuit **83** may determine whether or not the user is behind the drive wheel **31** based on the detection result of the distance sensor **73**. Further, the determining circuit **83** may even determine whether or not a distance detected by the distance sensor **73** is less than a predetermined distance threshold Ns. The distance threshold Ns may be a set distance (space between the manually propelled vehicle **1** and the user) where a possibility for the user to collide with the manually propelled vehicle **1** is sufficiently low even if the manually propelled vehicle **1** takes a sharp turn without hindrance in the operation of the manually propelled vehicle **1**. For example, a distance determined by an experiment or the like may be set to the distance threshold Ns. Alternatively, the distance threshold Ns may be a set value that can be changed by the manual operation of the user based on the information (e.g., correlation table information associated with the distance threshold Ns and the physique structure of the user) stored in a memory not illustrated.

These functional blocks are provided in order to realize assisting human power according to a walking posture and intent of the user by setting a variety of parameters of the wheel driver **91** according to the output of the grip sensor **71**. The parameters that are set may be, for example, various target values of a rotation direction, rotation speed, and rotation torque of the left and right motors **911**L and **911**R, or the like. The rotation torque of the left and right motors **911**L and **911**R may be set proportional to the output of the grip sensor **71**, or may be set based on the optimized correlation by ergonomics.

Further, when the output of the ground sensor **72** indicates that the drive wheel **31** is not grounded, the controller **80** may set a variety of parameters of the wheel driver **91** so as to stop or apply a brake of the electromotive drive of the wheel **30**. At that time, the controller **80** may further set the variety of parameters of the wheel driver **91** so that the target values of the speed and acceleration of the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) are lower than those of a steady state.

Furthermore, when at least one of the drive wheels **31** (left or right drive wheels **31**L and **31**R) is moving backward and it is determined by the determining circuit **83** that there is an object (e.g., a leg of the user) therebehind, the controller **80** may suppress or stop the electromotor drive of the wheel **30** (drive wheel **31**). The drive control of the wheel **30** will be described later.

The electromotor mechanism part **90** may be means to drive each part of the manually propelled vehicle **1** by an electromotor according to an instruction from the controller **80**. The electromotor **90** may comprise a wheel driver **91** that drives the wheel **30** by an electromotor according to the instruction from the controller **80** (see FIG. **2**). This wheel driver **91** may comprise the left and right wheel drivers **91**L and **91**R individually in order to control the left and right wheel drive wheels **31**L and **31**R independently.

FIG. **7** is a functional block diagram illustrating an example of one configuration of the wheel drivers **91**L and **91**E. The wheel drivers **91**L and **91**R may comprise motors **911**L and **911**R, motor drivers **912**L and **912**R, current sensors **913**L and **913**R, and rotation angle sensors **914**L and **914**R, respectively. Each of the motors **911**L and **911**R may rotate and drive the left and right drive wheels **31**L and **31**R independently. Each of the motor drivers **912**L and **912**R may be an inverter circuit for generating a drive current for the motors **911**L and **911**R according to respective control signals from the controller **80**. Each of the current sensors **913**L and **913**R may detect the driving current that respectively flows to the motors **911**L and **911**R. Each of the rotation angle sensors **914**L and **914**R may respectively detect a rotation angle of the motors **911**L and **911**R. Further, the rotation angle sensors **914**L and **914**R may also be used to detect a rotation speed of the motors **911**L and **911**R (or left and right drive wheels **31**L and **31**R). For example, a number or rotations (that is the rotation speed) per unit time may be found based on the number of output pulses per unit time outputted from the rotation angle sensors **914**L and **914**R. The rotation angle sensors **914**L and **914**R are not particularly limited; however, for example, a Hall sensor, resolver, rotary encoder, or the like may be used.

The wheel drive controller **82** may perform feedback control of the motor drivers **912**L and **912**R so as to match the rotation direction and rotation speed of the motors **911**L and **911**R with the target values according to each output of the current sensors **913**L, **913**R and the rotation angle sensors **914**L, **914**R.

An electric power source **100** may be means for supplying the electric power to the user interface **60**, sensor **70**, controller **80**, and the electromotor **90**. A secondary battery (such as a nickel-hydrogen battery or lithium-ion battery) attaching to the vehicle body **10** in a removable manner may be used for the electric power source **100**.

Next, a variety of parameters of the wheel driver **91** according to outputs of the grip sensor **71** will be described. FIG. **8** is an illustration of pressure distribution of the grip sensor **71** when moving by manual operation (when moving forward, moving backward, and braking). FIG. **8** is expressed such that black portions become darker as stronger pressure is applied to the grip sensor **71**. For example, when the user is pushing the grip **20** to move the manually propelled vehicle **1** forward, a thenar and a hypothenar (a thick portion near the wrist) of the palm that grips the grip **20** may strongly contact the grip sensor **71**. Accordingly, the pressure distribution of the grip sensor **71** may become a state where the front side of the grip sensor **71** (BC edge side viewing from the user) of the grip sensor **71** is applied with greater pressure; in other words, the positive acting force (force to push in the forward direction) may be excelled in the moving direction (X axis direction) of the manually propelled vehicle **1**. When detecting such pressure distribution, the controller **80** may set various parameters of the wheel driver **91** so as to move the manually propelled vehicle **1** forward smoothly and safely.

On the other hand, when the user is pulling the grip **20** to pull the manually propelled vehicle **1** backward, the balls of four fingers (forefinger, middle finger, ring finger, and little finger) that grip the grip the grip **20** may contact the grip sensor **71** strongly. Accordingly, the pressure distribution of the grip sensor **71** may become a state where the back side of the grip sensor **71** (AD edge side viewing from the user) of the grip sensor **71** is applied with greater pressure, in other words, the negative acting force (force to pull in the backward direction) may be superior in the moving direction (X axis direction) of the manually propelled vehicle **1**. The controller **80** may set the various parameters of the wheel driver **91** when such pressure distribution is detected so that the manually propelled vehicle **1** can be moved backward smoothly and safely.

Further, when the user is applying a brake on the manually propelled vehicle **1** by grasping the grip **20** tightly, the whole surface of the palm that grips the grip **20** may contact the grip sensor **71** strongly. Accordingly, the pressure distribution of the grip sensor **71** may become a state where large pressure is applied on the whole surface of the grip sensor **71**. Otherwise phrased, both positive and negative acting forces exceed a predetermined threshold in the moving direction (in X axis direction) of the manually propelled vehicle **1**, and also a difference between the two values is within a predetermined range. The controller **80** may set the various parameters of the wheel driver **91** when such pressure distribution is detected so that the manually propelled vehicle **1** can be applied a brake smoothly and safely.

Meanwhile, the controller **80** may determine that the user is not holding the grip **20** when the pressure exceeding the predetermined threshold is not applied to either of the right hand grip sensor **71**R and the left hand grip sensor **71**L. Then, the controller **80** may control the wheel driver **91** so as to stop or apply a brake of the electromotive drive of the wheel **30**. Therefore, for example, even when the user releases the hand from the grip **20** while walking downhill, the manually propelled vehicle **1** may automatically slow down or stops. Accordingly, the manually propelled vehicle **1** does not continue slipping down the downhill without the ability to apply a brake.

Furthermore, the controller **80** may determine that the user is holding the grip **20** with both hands when the pressure exceeding the predetermined threshold is applied to both the left hand grip sensor **71**L and the right hand grip sensor **71**R.

Also, the controller **80** may determine that the user is holding the grip **20** with one hand when the pressure exceeding the predetermined threshold is applied to only one side of the left hand grip sensor **71**L and the right hand grip sensor **71**R. Then, the controller **80** may carry out an appropriate turning assist control according to the judgment result. For example, when the drive wheel **31** is an opposed two-wheel type, the manually propelled vehicle **1** can be assisted to turn by controlling the rotation direction and rotation speed of the left and right drive wheels **31**L and **31**R.

For example, when slowly turning the manually propelled vehicle **1** left by both hands, the user may apply turning force to the manually propelled vehicle **1** towards the left while pushing the grip **20** forward by the right hand stronger than the left hand. In this case, the processor **81** may determine each target value of the rotation direction and rotation speed of the motors **911**L and **911**R individually according to the difference between the left and right acting forces applied onto the left grip sensor **71**L and the right grip sensor **71**R. Further, when slowly turning the manually propelled vehicle **1** to the left by one hand (left hand), the user may apply turning force to the manually propelled vehicle **1** towards the left by pushing the grip **20** forward by the thenar of the left hand while twisting the wrist to the left side so as to pulling the grip **20** draw closer by the balls of four fingers. In this case, the processor **81** may determine each target value of the rotation direction and rotation speed of the motors **911**L and **911**R individually according to the difference of each acting force applied onto the left and right half area of the left grip sensor **71**L. Then, the controller **80** may drive and control the right drive wheel **31**R to drive stronger than that of the left drive wheel **31**L. When turning the manually propelled vehicle **1** right by both hands or one hand (right hand), the left drive wheel **31**L and the right drive wheel **31**R may be driven and controlled in the same way by reversing the left and right. In this manner, when turning the manually propelled vehicle **1** slowly, the left drive wheel **31**L and the right drive wheel **31**R may be driven forward by a different driving force.

Meanwhile, when turning the manually propelled vehicle **1** sharply, there is a case where the drive wheel **31** of inner wheel side is driven rearward. For example, when turning while the manually propelled vehicle **1** is a stationary state, or when turning by operating the grip **20** so as to push hard one side of left or right of the grip **20** forward and also push the other side backward, one of the drive wheels **31** may be driven rearward. A description of a turning assisting function of the manually propelled vehicle **1** in such case is given with reference to specific examples.

FIG. **9** is a flowchart to describe an operation of a turning assist function of the manually propelled vehicle **1**. A process illustrated as an example in FIG. **9**, for example, starts when the wheel **30** is driven, and ends when the wheel **30** stops.

First, a distance sensor **73** may detect a distance N to the rearward object (user) (step S**101**). Then, a determining circuit **83** may determine whether or not the distance N is less than the predetermined distance threshold Ns (step S**102**).

When determining circuit **83** determines that the distance is less than the distance threshold Ns (YES in step S**102**), it is determined that the user is directly behind the manually propelled vehicle **1**, and it is estimated that the user is not behind the drive wheel **31**. In this case, the processor **81** may detect distribution of pressure applied to the grip sensor **71** by the user (step S**103**). Further, the processor **81** may calculate rotation target values (target values of rotation direction and rotation torque) of the left and right motors **911**L and **911**R based on the detected pressure distribution (step S**104**). Furthermore, processor **81** may calculate a set value of driving currents that supply to the left and right motors **911**L and **911**R based on the calculated rotation target value (step S**105**). Then, the process proceeds to step S**111** that will be described later.

On the other hand, when it is determined that the distance is not less than the distance threshold Ns (NO in step S**102**), the estimation is made that the user is behind one side of the manually propelled vehicle **1**, and particularly behind the drive wheel **31** (either one of left or right drive wheel **31**L or **31**R). In this case, the processor **81** may detect distribution of pressure applied to the grip sensor **71** by the user (step S**106**). Further, the processor **81** may calculate rotation target values (target values of rotation direction and rotation torque) of the left and right motors **911**L and **911**R based on the detected pressure distribution (step S**107**).

Next, the determining circuit **83** may detect whether or not at least one side of the left or right drive wheels **31**L or **31**R is driven in the rearward direction based on the calculated rotation target value (step S**108**). When it is determined that neither are driven in the rearward direction (NO in step S**108**), the process proceeds to step S**105**.

When it is determined that at least one side is driven in the rearward direction (YES in step S**108**), the processor **81** may calculate set values of the driving currents of the left and right motors **911**L and **911**R based on the calculated rotation target value (step S**109**). Further, the processor **81** may set the set value of the drive current of the motor **911** that drives the rearward moving drive wheel **31** to a value smaller than the calculated set value or to 0 (step S**110**). By this setting, the rearward moving drive wheel **31** can be braked or held back (stopped). Then, the process proceeds to step S**111** that will be described later.

In step S**111**, the left and right motor drivers **912**L and **912**R respectively generate driving currents corresponding to the calculated or the set value and supply the generated driving currents to the motors **911**L and **911**R. Then, the process returns to step S**101**.

According to the turning assist function described above, it can be estimated whether or not the user is behind one side (particularly behind drive wheel **31**) of the manually propelled vehicle **1** based on the detected result of the distance sensor **73** disposed on the backside surface of the vehicle body **10**. Further, when it is estimated that the user is behind one side, the rearward moving drive wheel **31** may be driven and controlled so as to be braked or stopped at the time of turning the manually propelled vehicle **1** sharply. Accordingly, when turning the manually propelled vehicle **1**, the user can be prevented from colliding into the manually propelled vehicle **1** and a leg of the user can be prevented from contacting against the drive wheel **31**. Accordingly, the possibility of accidents occurring thereby can be significantly reduced.

Next, a description of the turning assist function of the manually propelled vehicle **1** is given in detail with reference to two embodiments using the distance sensor **73** and a comparative example without using the distance sensor **73**.

EXAMPLE 1

First, a description is given of when an manually propelled vehicle **1** is turned sharply with both hands. FIG. **10** is an explanatory diagram of a turning assist function when the manually propelled vehicle **1** is turned sharply operated with both hands. When it is determined that the user is operating the grip **20** with both hands, a processor **81** that monitors output of the grip sensor **71** may compare a distribution of pressure applied by the left hand and a distribution of pressure applied by the right hand. Then, the processor **81** may set a turning target value of the left and right drive wheels **31**L and **31**R according to the comparison result of the pressure distribution of the grip **20** and the detected result of the distance sensor **73**.

FIG. **11** is an explanatory diagram of the turning operation when the manually propelled vehicle **1** in one or more embodiments of the first example is turned sharply with both hands. For example, when the manually propelled vehicle **1** is turned sharply to the left with both hands as illustrated in FIG. **11**, the user may apply acting force F×L to the left side of the grip **20** to draw closer to the user (rearward) with the left hand, and applies acting force F×R to the right side of the grip **20** to push forward with the right hand. By this operation, the turning force to the left may be given to the manually propelled vehicle **1**. Then, the left drive wheel **31**L may be driven rearward and the right drive wheel **31**R may be driven forward.

When distance N outputted by the distance sensor **73** is not less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** does not detect the user), it may be estimated that the user has moved relatively behind one side (left side) of the manually propelled vehicle **1** as illustrated in FIG. **11**, and particularly behind the left drive wheel **31**L. Therefore, the right drive wheel **31**R may be driven forward by driving force DR corresponding to the right acting force F×R; however, the left drive wheel **31**L may be driven backward by driving force DLa that is smaller than the driving force DL corresponding to the left acting force F×L. Alternatively, the left drive wheel **31**L may be controlled so as not to drive backwards. That is, the rearward moving left drive wheel **31**L may be braked or stopped by the drive control ($0 \leq DLa < DL$).

Meanwhile, when distance N outputted by the distance sensor **73** is less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** detects the user), the user may be directly behind the manually propelled vehicle **1**, and accordingly, it may be estimated that the user is not behind the drive wheel **31** and, particularly, not behind the left drive wheel **31**L. Therefore, the left drive wheel **31**L may be driven backwards by the driving force DL corresponding to the left acting force F×L, and the right drive wheel **31**R may be driven forward by the driving force DR corresponding to the right acting force F×R.

Further, contrary to FIG. **11**, the similar control may also be performed when turning the manually propelled vehicle **1** sharply to the right with both hands. In this case, the user may apply acting force F×L to push forward onto the left side of the grip **20** by the left hand, and may apply acting force F×R to draw closer to the user (rearward) onto the right side of the grip **20** by the right hand. By this operation, the turning force to the right may be given to the manually propelled vehicle **1**. Then, the left drive wheel **31**L may be driven forward and the right drive wheel **31**R may be driven backwards.

When distance N outputted by the distance sensor **73** is not less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** does not detect the user), it may be estimated that the user has moved relatively behind one side (right side) of the manually propelled vehicle **1**, and particularly behind the right drive wheel **31**R. Therefore, the left drive wheel **31**L may be driven forward by driving force DL corresponding to the left acting force F×L; however, the right drive wheel **31**R may be braked and driven backwards by driving force DRa that is smaller than the driving force DR corresponding to the left acting force F×R. Alternatively, the right drive wheel **31**R may be controlled so as not to drive backwards. That is, the rearward moving right drive wheel **31**R may be braked or stopped by the drive control ($0 \leq DRa < DR$).

Meanwhile, when distance N outputted by the distance sensor **73** is less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** detects the user), the user may be directly behind the manually propelled vehicle **1**, and accordingly, it is estimated that the user is not behind the drive wheel **31**. Therefore, the left drive wheel **31**L may be driven forward by the driving force DL corresponding to the left acting force F×L, and the right drive wheel **31**R may be driven backward by the driving force DR corresponding to the right acting force F×R.

As a result of such drive control, the left and right drive wheels **31**L and **31**R may assist the left turn or right turn of the manually propelled vehicle **1** and may also be driven and controlled independently so as not to collide the manually propelled vehicle **1** into the user. Accordingly, even if the user cannot move in accordance with the turning of the manually propelled vehicle **1**, a collision with the user can be buffered or prevented who is behind one side of the manually propelled vehicle **1**. Furthermore, it may significantly reduce the risk where a leg of the user contacts the rearward moving drive wheel **31** and get involved in a dangerous situation.

EXAMPLE 2

Next, a description is given of when an manually propelled vehicle **1** is turned sharply with one hand. FIG. **12** is an explanatory diagram of a turning assist function of when the manually propelled vehicle **1** in one or more embodiments of the first example is turned sharply with one hand (a left hand operation in the example illustrated in the FIG.). When it is determined that the user is operating the grip **20** with one hand, a processor **81** that monitors output of the grip sensor **71** may divide the region where pressure is applied by one hand into two sub-regions. When left hand grip sensor **71**L and right hand grip sensor **71**R are provided separately, the grip sensor **71** held with one hand may be divided into two sub-regions. For example, as illustrated in FIG. **12**, the left hand grip sensor **71**L that is held with the left hand may divide regions into a first sub-region **71**L**1** and a second sub-region **71**L**2**. Then, the processor **81** may set a turning target value of the left and right drive wheels **31**L and **31**R according to the comparison result of the pressure distribution applied to each sub-region and the detected result of the distance sensor **73**.

For example, when the manually propelled vehicle **1** is turned sharply to the left with the left hand, the user may twist the left wrist to the left by pulling the left side of the grip **20** with the finger pads of four fingers of the left hand while pushing the left side of the grip **20** with the thenar of the left hand so as to push forward. That is, the user may apply an acting force F×L**1** drawing closer to the user (rearward) to the first sub-region **71**L**1** of the left hand grip sensor **71**L, and may apply an acting force F×L**2** pushing forward to the second sub-region **71**L**2** of the left hand grip sensor **71**L. By this operation, the turning force in the left direction may be given to the manually propelled vehicle **1**. Then, the left drive wheel **31**L may be driven backwards and the right drive wheel **31**R may be driven forwards.

When distance N outputted by the distance sensor **73** is not less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** does not detect the user), it may be estimated that the user has moved relatively behind one side (left side) of the manually propelled vehicle **1**, and particularly behind the left drive wheel **31**L. Therefore, the right drive wheel **31**R may be driven forward by driving force

DR corresponding to the acting force F×L2; however, the left drive wheel **31**L may be braked and driven backward by driving force DLa that is smaller than the driving force DL corresponding to the acting force F×L**1**. Alternatively, the left wheel **31**L may be controlled so as not to drive backwards. That is, the rearward moving left drive wheel **31**L may be braked or stopped by the drive control (0≤DLa<DL).

Meanwhile, when distance N outputted by the distance sensor **73** is less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** detects the user), the user may be directly behind the manually propelled vehicle **1**. Accordingly, it may be estimated that the user is not behind the drive wheel **31**. Therefore, the left drive wheel **31**L may be driven backwards by the driving force DL corresponding to the acting force F×L**1**, and the right drive wheel **31**R may be driven forward by the driving force DR corresponding to the right acting force F×L**2**.

Further, conversely, when the manually propelled vehicle **1** is turned sharply to the right with the left hand, the user may twist the left wrist to the right by pulling the grip **20** with the finger pads of four fingers of the left hand while pushing the grip **20** with the antithenar of the left hand so as to push forward. By this operation, the turning force in the right direction may be given to the manually propelled vehicle **1**. Then, the left drive wheel **31**L may be driven forwards and the right drive wheel **31**R is driven backwards.

When distance N outputted by the distance sensor **73** is not less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** does not detect the user), it may be estimated that the user has moved relatively behind one side (right side) of the manually propelled vehicle **1**, and particularly behind the right drive wheel **31**R. Therefore, the left drive wheel **31**L may be driven forward by driving force DL corresponding to the acting force F×L**1**; however, the right drive wheel **31**R may be braked and driven backwards by driving force DRa that is smaller than the driving force DR corresponding to the acting force F×L**2**. Alternatively, the right drive wheel **31**R may be controlled so as not to drive backwards. That is, the rearward moving right drive wheel **31**R may be braked or stopped by the drive control (0≤DRa<DR).

Meanwhile, when distance N outputted by the distance sensor **73** is less than the predetermined distance threshold Ns (in other words, when the distance sensor **73** detects the user), the user may be directly behind the manually propelled vehicle **1**, and accordingly, it is estimated that the user is not behind the drive wheel **31**. Therefore, the left drive wheel **31**L may be driven forwards by the drive force DL corresponding to the acting force F×L**1**, and right drive wheel **31**R may be driven backwards by the driving force DR corresponding to the right acting force F×L**2**.

As a result of these drive controls, the left and right drive wheels **31**L and **31**R may assist the left or right turn of the manually propelled vehicle **1**, and may also be driven and controlled independently so as to prevent a collision of the manually propelled vehicle **1** and the user. Therefore, even if the user cannot move with the turning movement of the manually propelled vehicle **1**, it may be possible to buffer or prevent a collision from the user who is behind one side of the manually propelled vehicle **1**. Moreover, the entanglement risk of a leg of the user contacting the drive wheel **31** can be reduced. The turning operation of the ambulatory assist **1** in the FIG. **12** is performed with the left hand; however, it also can be driven and controlled in a similar manner when performing the turning operation with the right hand.

COMPARATIVE EXAMPLE

Next, a description is given of when an manually propelled vehicle **1**A that is not equipped with the distance sensor **73** is turned sharply in order to confirm the operation and effects of the distance sensor **73** provided in the manually propelled vehicle **1**. FIG. **13** is an explanatory diagram of a turning operation when the manually propelled vehicle **1**A that is not equipped with the distance sensor **73** is turned sharply with both hands. The manually propelled vehicle **1**A of the comparative example is configured similarly as the manually propelled vehicle **1** of one or more embodiments of the present examples other than that the distance sensor **73** is not provided.

For example, when turning the manually propelled vehicle **1**A sharply to the left with both hands as illustrated in FIG. **13**, the left drive wheel **31**L is driven backwards by driving force DL corresponding to left acting force F×L to draw the left side of the grip **20** closer to the user (rearward). Further, the right drive wheel **31**R is driven forward by the driving force DR corresponding to the right acting force F×R to push the right side of the grip **20** forward.

Accordingly, if the user cannot move in accordance with the turning of the manually propelled vehicle **1**A, the user would move relatively to the rearward on one side (left side in FIG. **13**) of the manually propelled vehicle **1**A and collide against the manually propelled vehicle **1**A. Furthermore, if a leg of the user moves to behind the drive wheel **31** (left drive wheel **31**L in FIG. **13**) of the inner wheel side of the turning manually propelled vehicle **1**A, there is a risk of getting entangled and injuring the leg by contacting the drive wheel **31**.

As described above, the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) according to one or more embodiments of the first example may comprise the vehicle body **10**, drive wheel **31**, wheel driver **91**, distance sensor **73**, determining circuit **83**, and controller **80**. The drive wheel **31** may comprise the left and right drive wheels **31**L and **31**R that are driven and controlled independently and used for traveling the vehicle body **10** in accordance with walking by the user. The wheel driver **91** may electromotively drive the drive wheels **31** (left and right drive wheels **31**L and **31**R). The distance sensor **73** functions as a detecting part to detect the user located behind the vehicle body **10**. The determining circuit **83** determines whether or not the user is behind the drive wheel **31** based on the detected result of the distance sensor **73**. Further, when it is determined that one of the left or right drive wheels **31**L or **31**R moves backward and also that the user is behind on that side, the controller **80** may suppress or stop the electromotor drive of that side. By having such configuration, for example, even if one of the left or right drive wheels **31**L or **31**R has moved rearward when turning the manually propelled vehicle **1**, the electromotor drive of one of the rearward moving left or right drive wheels **31**L or **31**R may be suppressed or stopped when it is determined that the user is behind the rearward driving drive wheels **31**L or **31**R. Accordingly, when the manually propelled vehicle **1** is turned, a collision with the user, who is on one side of the manually propelled vehicle **1**, can be buffered or prevented because the turning of the manually propelled vehicle **1** can be braked or stopped.

Further, in the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) in one or more embodiments of the first example, the distance sensor **73** may be provided between the left and right drive wheels **31**L and **31**R in order to detect whether or not the user is behind the vehicle body **10** except behind the left or right drive wheels **31**L and **31**R in a planar view when viewed from vertically above. The distance sensor **73** may output a distance N to an object (e.g. user) located behind the distance sensor **73**. Furthermore, when one of the left or right drive wheels **31**L or **31**R has moved backward and also the distance N is not less than the distance threshold Ns, the controller **80** may suppress or stop the electromotor drive of that side of the left or right drive wheels **31**L or **31**R. By having such configuration, for example, when turning the manually propelled vehicle **1**, the distance sensor **73** provided between the left and right drive wheels **31**L and **31**R can detect whether or not the user is behind the vehicle body **10** except behind the left or right drive wheel **31**L and **31**R. Furthermore, when the distance N outputted by the distance sensor **73** is not less than the distance threshold Ns, it may be estimated that the user is behind the rearward moving drive wheels **31**L or **31**R side. Then, the electromotor drive of one of rearward moving drive wheel **31**L or **31**R may be suppressed or stopped. Accordingly, a collision between the user and the manually propelled vehicle **1** can be buffered or prevented by the distance sensor **73** provided between the left and right drive wheels **31**L and **31**R.

Further, in the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) in one or more embodiments of the first example, the distance sensor **73** may detect whether or not a leg of the user is behind the wheel **30**. By having such configuration, the contact between the leg of the user and the rearward moving drive wheels **31**L or **31**R side can be prevented, or the impact at the time of contact can be buffered.

<Second Embodiment>

FIG. **14** is an external view of an manually propelled vehicle **1** according to one or more embodiments of a second example. The lower part of FIG. **14** schematically illustrates in order from the left on the sheet, a left side view, and a posterior view (back view) of the manually propelled vehicle **1**. Further, in the upper part of FIG. **14**, a top view of manually propelled vehicle **1** is schematically illustrated. One or more embodiments of the second example may have fundamentally the same configuration as one or more embodiments of the first example, and may have a feature where a distance sensor **73** is provided in both left and right sides on a backside surface **10***a* of a vehicle body **10** as a configuration element in order to detect whether or not a user is behind one side (particularly behind drive wheel **31**) of the manually propelled vehicle **1**. Accordingly, the same or similar configuration elements as those in one or more embodiments of the first example are given the same referential codes, and a duplicated description will be omitted. Descriptions of a feature of one or more embodiments of the second example will be focused and given hereinafter.

The distance sensor **73** may comprise a left and right distance sensor **73**L and **73**R. The left and right distance sensor **73**L and **73**R may respectively be provided in the left side and right side on the backside surface **10***a* of the vehicle body **10** as illustrated in the posterior view in FIG. **14**, and also be disposed above the left and right drive wheels **31**L and **31**R as illustrated in each illustration in FIG. **14**. By describing more specifically, the left side distance sensor **73**L may be disposed at a location that is superimposed on the left drive wheel **31**L in a planar view when viewing the manually propelled vehicle **1** from vertically above or near the left drive wheel **31**L. Further, the right side distance sensor **73**R may be disposed at a location that is superimposed on the right drive wheel **31**R in a planar view when viewing the manually propelled vehicle **1** from vertically above or near the left drive wheel **31**R. The left and right distance sensors **73**L and **73**R output distance N to an object (e.g., user) located behind each thereof.

FIG. **15** is a side view illustrating a location of the distance sensor **73** according to one or more embodiments of the second example. The disposed locations in the vertical direction of the distance sensor **73** (left and right distance sensors **73**L and **73**R) are not particularly limited; and the left and right distance sensors **73**L and **73**R may be disposed respectively in locations that detect the left and right legs of the user as illustrated in FIG. **15**. Alternatively, they may be disposed respectively in locations that detect a torso of the user.

Next, a description of a turning assist function of the manually propelled vehicle **1** that provides the left and right distance sensors **73**L and **73**R. FIG. **16** is an explanatory diagram of a turning operation when the manually propelled vehicle **1** in one or more embodiments of the second example is turned sharply with both hands. For example, if turning the manually propelled vehicle **1** sharply to the left with both hands as illustrated in FIG. **16**, the left drive wheel **31**L may be driven backward and the right drive wheel **41**R may be driven forward. At that time, when the distance N outputted by the left side distance sensor **73**L is less than a predetermined distance threshold Ns (in other words, when the distance sensor **73**L detects the user), it may be determined that the user has moved relatively behind one side (left side) of the manually propelled vehicle **1**, and particularly behind the left drive wheel **31**L. Therefore, the right drive wheel **31**R is driven forward by the driving force DR corresponding to the right acting force F×R to push the right side of the grip **20** forward; however, the left drive wheel **31**L may be braked and driven backward by the driving force DLa by being braked. The driving force DLa may be set smaller than that of the driving force DL corresponding to the left acting force F×L that draws the left side of the grip **20** closer to the user (backward). Alternatively, the left drive wheel **31**L may be controlled so as not to drive backwards. That is, the rearward moving left drive wheel **31**L may be braked or stopped by the drive control ($0 \leq DLa < DL$).

On the contrary to FIG. **16**, if the manually propelled vehicle **1** is turned sharply to the right side with both hands, the left drive wheel **31**L may be driven forward and the right drive wheel **31**R is driven backward. At that time, when the distance N outputted by the right side distance sensor **73**R is less than the predetermined distance threshold Ns (in other words, when the distance sensor **73**R detects the user), it may be determined that the user has moved relatively behind one side (right side) of the manually propelled vehicle **1**, and particularly behind the right drive wheel **31**R. Therefore, the left drive wheel **31**L may be driven forward by the driving force DL corresponding to the left acting force F×L; however, the right drive wheel **31**R may be braked and driven backward by the driving force DRa. This driving force DRa may be set smaller than that of the driving force DR corresponding to the right acting force F×R. Alternatively, the right drive wheel **31**R may be controlled so as not to drive backwards. That is, rearward moving right drive wheel **31**R may be braked or stopped by the drive control ($0 \leq DRa < DR$).

On the other hand, even when the manually propelled vehicle **1** is turned sharply, there is a case in which the distances N outputted from both left and right distance sensors **73**L and **73**R are not less than a predetermined distance threshold Ns (in other words, both the left and right distance sensors **73**L and **73**R do not detect the user). In this case, it may be determined that the user is not behind the left or right drive wheels **31**L and **31**R because the user is directly behind the manually propelled vehicle **1**. Therefore, the left drive wheel **31**L may be driven backwards by the driving force DL corresponding to the left acting force F×L, and the right drive wheel **31**R may be driven forward by the driving force DR corresponding to the right acting force F×R.

As a result of such drive control, the left and right drive wheels **31**L and **31**R may assist the left turn or right turn of the manually propelled vehicle **1** and may also be driven and controlled independently so as not to collide the manually propelled vehicle **1** into the user. Accordingly, even if the user cannot move in accordance with the turning of the manually propelled vehicle **1**, a collision with the user can be buffered or prevented who is behind one side of the manually propelled vehicle **1**. Furthermore, the entanglement risk of a leg of the user coming in contact with the drive wheel **31** can be reduced. The descriptions described above were given when turning the manually propelled vehicle **1** sharply with both hands; however, it can be driven and controlled in a similar manner when turning to the left or right sharply by a one hand operation.

As described above, in the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) in one or more embodiments of the second example, the distance sensors **73**L and **73**R provided above the left and right drive wheel **31**L and **31**R, respectively, may function as a detecting part. The distance sensors **73**L and **73**R may output the distance to an object located behind the distance sensors **73**L and **73**R, respectively. Further, if one of the left or right drive wheels **31**L or **31**R has moved backward and also if the distance N outputted by the distance sensors **73**L or **73**R provided above that side is less than the distance threshold Ns, the controller **80** may suppress or stop the electromotor drive of that side of the left or right drive wheel **31**L or **31**R. By having such configuration, for example, when turning the manually propelled vehicle **1**, if the distance N outputted by the distance sensor **73**L or **73**R above the rearward moving drive wheel **31**L or **31**R side is less than the threshold Ns, it may be determined that the user is behind the rearward moving drive wheel **31**L or **31**R. Then, the electromotor drive of that side which is the rearward moving drive wheel **31**L or **31**R may be suppressed or stopped. Accordingly, a collision between the user and the manually propelled vehicle **1** can be surely buffered or prevented by the distance sensors **73**L and **73**R respectively provided above the left and right drive wheels **31**L and **31**R.

<Third Embodiment>

One or more embodiments of the third example may have fundamentally the same configuration as one or more embodiments of the first example above, and has a feature where a range sensor **74** is provided instead of the distance sensor **73** as the configuration element in order to detect the location of the user behind the manually propelled vehicle **1**. Accordingly, the same or similar configuration elements as those in one or more embodiments of the first example are given the same referential codes, and a duplicated description will be omitted. Descriptions of a feature of one or more embodiments of the third example will be focused and given hereinafter.

The range sensor **74** may be, for example, a laser scanner of single-axis scanning that scans a predetermined scanning plane semicircularly behind the manually propelled vehicle **1** using a laser beam. The range sensor **74** may be provided on the backside surface **10***a* of the vehicle body **10** and is disposed between the left and right drive wheels **31**L and **31**R in a planar view when viewing the manually propelled vehicle **1** from vertically above. The range sensor **74** may scan behind the vehicle body **10** and functions as a detecting part that detects a location of a user (for example, relative direction and distance).

Next, a turning assist function of the manually propelled vehicle **1** that provides the range sensor **74** will be described. FIG. **17** is an explanatory diagram of a turning operation of when the manually propelled vehicle **1** of one or more embodiments of the third example is turned sharply with both hands. When the manually propelled vehicle **1** has a turning motion, the range sensor **74** may scan the scanning plane P (e.g., horizontal plane) semicircularly to detect a location of the user who is behind the manually propelled vehicle **1**. The scanning plane P may be set, for example, so as to detect a location of the torso of the user, or set to detect a location of a leg of the user. The determining circuit **83** may determine based on the detected result of the range sensor **74**, whether or not at least one portion of the body of the user is within a region A illustrated in a shaded area in FIG. **17**. The region A may be configured of a region AL behind the left drive wheel **31**L and a region AR behind the right drive wheel **31**R. A width from the backside surface **10***a* of each of the region AL and AR may be set the width same as the distance threshold Ns. Further, a processor **81** that monitors output of a grip sensor **71** may compare a distribution of pressure applied by the left hand and a distribution of pressure applied by the right hand. Then, the processor **81** may set a turning target value of the left and right drive wheels **31**L and **31**R according to the detecting result of the distance sensor **73**, the determining result of the determining circuit **83**, and the comparison result of the pressure distribution of the grip **20**.

For example, if turning the manually propelled vehicle **1** sharply to the left with both hands as illustrated in FIG. **17**, the left drive wheel **31**L may be driven backward and the right drive wheel **41**R is driven forward. At that time, when the range sensor **74** detects at least a portion of the body of the user within the left side region AL, it may be determined that the user has moved relatively behind one side (left side) of the manually propelled vehicle **1** as illustrated in FIG. **17**, particularly behind the left drive wheel **31**L. Therefore, the right drive wheel **31**R may be driven forward by driving force DR corresponding to right acting force F×R to push the right side of the grip **20** forward; however, the left drive wheel **31**L may be braked and driven backward by driving force DLa by being braked. The driving force DLa may be set smaller than that of the driving force DL corresponding to the left acting force F×L that draws the left side of the grip **20** closer to the user (backward). Alternatively, the left drive wheel **31**L may be controlled so as not to drive backwards. That is, the rearward moving left drive wheel **31**L may be braked or stopped by the drive control ($0 \leq DLa < DL$).

On the contrary to FIG. **17**, if turning the manually propelled vehicle **1** sharply to the right side with both hands, the left drive wheel **31**L may be driven forward and the right drive wheel **31**R is driven backward. At that time, when the range sensor **74** may detect at least a portion of the body of the user within the right side region AR, it may be determined that the user has moved relatively behind one side (right side) of the manually propelled vehicle **1**, particularly behind the right drive wheel **31**R. Therefore, the left drive wheel **31**L may be driven forward by the driving force DL corresponding to the left acting force F×L; however, the right drive wheel **31**R may be braked and controlled and driven backward by the driving force DRa. This driving force DRa may be set smaller than that of the driving force DR corresponding to the right acting force F×R. Alternatively, the right drive wheel **31**R may be controlled so as not to drive backwards. That is, the rearward moving right drive wheel **31**R may be braked or stopped by the drive control ($0 \leq DRa < DR$).

On the other hand, when the range sensor **74** does not detect at least a portion of the body of the user within the region A (that is the left and right regions AL and AR), it may be determined that the user is directly behind the manually propelled vehicle **1**, so the user is not behind the left and right drive wheels **31**L and **31**R. Therefore, the left drive wheel **31**L may be driven backwards by the driving force DL corresponding to the left acting force F×L, and the right drive wheel **31**R may be driven forward by the driving force DR corresponding to the right acting force F×R.

As a result of such drive control, the left and right drive wheels **31**L and **31**R may be driven and controlled independently so as to assist left turn or right turn of the manually propelled vehicle **1**. Thus, a collision between the manually propelled vehicle **1** and the user can be prevented. Accordingly, even if the user cannot move in accordance with the turning motion of the manually propelled vehicle **1**, a collision against the user who is behind on one side of the manually propelled vehicle **1** can be buffered or prevented. Furthermore, the entanglement risk of a leg of the user coming in contact with the drive wheel **31** can be reduced. The descriptions were illustrated as an example when turning the manually propelled vehicle **1** sharply with both hands in FIG. **17**; however, the same process may apply when turning to the left or right sharply by a one hand operation.

Further, the laser scanner of single-axis scanning may be used for the range sensor **74** in the above description; however, a three-dimensional scanner of two-axis scanning type may be used. Accordingly, rearward of the manually propelled vehicle **1** can be scanned semicircularly, and therefore, it can detect a three-dimensional position of the user rearward of the manually propelled vehicle **1**. Thus, it can detect accurately and quickly whether or not the user will collide into the manually propelled vehicle **1**.

Further, the setting of the region A (or left and right regions AL and AR) is not limited to the illustrated example of FIG. **17**. For example, the optimized region by using ergonomics may be set or a region that can be changed by manual operation of the user using a user interface **60** for the region A (or left and right regions AL and AR).

As described above, in the manually propelled vehicle **1** (e.g., ambulatory assist vehicle) in one or more embodiments of the third example, the range sensor **74** that detects a location of the user by scanning rearward of the vehicle body **10** may function as the detecting part. By having such configuration, the location of the user behind the vehicle body **10** can be detected by the range sensor **74**. Accordingly, one or more embodiments can determine accurately whether or not the user is behind the drive wheel **31** (particularly rearward moving drive wheel **31** or **31**R) based on the detecting position of the user.

OTHER ALTERNATIVE EXAMPLES

An manually propelled vehicle **1** is described as an example in the embodiments described above; however, the application of the present invention is not limited thereto and can be widely applied to even other manually propelled vehicles (such as baby carriages, dollies, wheelchairs, and the like).

Further, in the embodiments described above, the processor **81**, wheel drive controller **82**, and the determining circuit **83** may be a functional block of the logic circuit such as microcomputer; however, the applicable scope of the present invention is not limited to the illustrated examples. All of them or at least one portion may be a physical configuration element such as an electronic circuit.

Furthermore, in the embodiments described above, when the manually propelled vehicle **1** is turned sharply, if it is determined that the user is behind the rearward moving drive wheel **31**, the electromotor drive of the rearward moving drive wheel **31** may be designed to be braked or stopped; however, the applicable scope of the present invention is not limited the illustrated examples. A configuration may be designed so that the electromotor of the moving forward drive wheel **31** is also driven and controlled to brake or stop in order to have a proper turning motion of the manually propelled vehicle **1**.

Various embodiments of the present invention have been described above; however, the present invention is not limited to these embodiments. In particular, those skilled in the art can add various modifications to these embodiments without departing from the scope of the invention. Also, the features of these embodiments can be used in various combinations with each other, and are not intended to be limited to the specific combinations disclosed herein. That is, the embodiments described above should be considered as exemplifications in all respects and are not restricted, and the technical scope of the present invention is indicated by the scope of claims rather than the descriptions of the embodiments described above.

[Industrial Applicability]

One or more embodiments of the present invention can be used for safety improvement and convenience enhancement of a manually propelled vehicle.

Although the disclosure has been described with respect to only a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that various other embodiments may be devised without departing from the scope of the present invention. Furthermore, those of ordinary skill in the art would appreciate that certain “units,” “parts,” “elements,” or “portions” of one or more embodiments of the present invention may be implemented by a circuit, processor, etc. using known methods. Accordingly, the scope of the invention should be limited only by the attached claims.

[Description of the Reference Numerals]

1, **1**A manually propelled vehicle (e.g., ambulatory assist vehicle)
10 vehicle body
10*a* backside surface
11 baggage compartment
20 grip
21 support part
22 (**22**L, **22**R) grip (left and right)
30 wheel
31 (**31**, **31**R) drive wheel (left and right)
32 (**32**L, **32**R) idler wheel (left and right)
40 seat (and baggage compartment upper lid)
50 backrest
60 user interface
61 manual operation part
62 notification part (e.g., speaker)
70 sensor
71 (**71**L, **71**R) grip sensor (left and right)
72 ground sensor
73 (**73**L, **73**R) distance sensor (left and right)
74 range sensor
80 controller
81 processor
82 wheel drive controller
83 determining circuit
90 electromotor
91 (**91**L, **91**R) wheel driver (left and right)
911 (**911**L, **911**R) motor (left and right)
912 (**912**L, **912**R) motor driver (left and right)
913 (**913**L, **913**R) current sensor (left and right)
914 (**914**L, **914**R) rotation angle sensor (left and right)
100 power source
PS pressure sensor

What is claimed is:

1. A manually propelled vehicle, comprising:
a vehicle body;
a left drive wheel and a right drive wheel;
a wheel driver that drives the left and right drive wheels;

a sensor that detects a user behind the vehicle body; and

a controller that determines whether the user is behind the left or right drive wheel based on a detected result of the sensor, wherein

when one of the left or right drive wheel moves backward and the controller detects that the user is behind the one of the left or right drive wheel, the controller suppresses or stops the wheel driver from driving the one of the left or right drive wheel.

2. The manually propelled vehicle according to claim **1**, wherein

the sensor comprises a distance sensor provided between the left and right drive wheels and that detects whether the user is behind the vehicle body in an area that is not behind the left or right drive wheel when viewed from vertically above in a planar view,

the distance sensor outputs a distance to an object located behind the distance sensor, and

when the one of the left or right drive wheel moves backward and the distance output by the distance sensor is greater than or equal to a threshold, the controller suppresses or stops the wheel driver from driving the one of the left or right drive wheel.

3. The manually propelled vehicle according to claim **1**, wherein

the sensor comprises a distance sensor provided respectively above the left and right drive wheels,

each of the distance sensors respectively outputs a distance to an object located behind the distance sensor, and

when the one of the left or right drive wheel moves backward and the distance output by the distance sensor provided above the one of the left or right drive wheel is less than a threshold, the controller suppresses or stops the wheel driver from driving the one of the left or right drive wheel.

4. The manually propelled vehicle according to claim **1**, wherein the sensor comprises a range sensor that detects a location of the user by scanning behind the vehicle body.

5. The manually propelled vehicle according to claim **1**, wherein the sensor detects whether a leg of the user is behind the left or right drive wheel.

6. A method for controlling a manually propelled vehicle comprising a vehicle body, a left drive wheel and a right drive wheel, and a wheel driver that drives the left and right drive wheels, the method comprising:

detecting a user behind the vehicle body;

determining whether the user is behind the left or right drive wheel based on the detecting; and

when one side of the left or right drive wheel moves backward and the determining determines that the user is behind the one side of the left or right drive, suppressing or stopping the wheel driver from driving the one of the left or right drive wheel.

7. The method according to claim **6**, further comprising:

detecting, with a distance sensor provided between the left and right drive wheels, whether the user is behind the vehicle body in an area that is not behind the left or right drive wheel when viewed from vertically above in a planar view;

outputting a distance to an object located behind the distance sensor; and

when the one of the left or right drive wheel moves backward and the distance is greater than or equal to a threshold, suppressing or stopping the wheel driver from driving the one of the left or right drive wheel.

8. The method according to claim **6**, further comprising:

detecting, with each of distance sensors provided respectively above the left and right drive wheels, a distance to an object located behind the respective distance sensors;

outputting the distance to the object; and

when the one side of the left or right drive wheel moves backward and the distance output by the distance sensor provided above the one of the left or right drive wheel is less than a threshold, suppressing or stopping the wheel driver from driving the one of the left or right drive wheel.

9. The method according to claim **6**, further comprising detecting a location of the user by scanning behind the vehicle body.

10. The method according to claim **6**, further comprising detecting whether a leg of the user is behind the left or right drive wheel.

11. The manually propelled vehicle according to claim **2**, wherein the sensor detects whether a leg of the user is behind the left or right drive wheel.

12. The manually propelled vehicle according to claim **3**, wherein the sensor detects whether a leg of the user is behind the left or right drive wheel.

13. The manually propelled vehicle according to claim **4**, wherein the sensor detects whether a leg of the user is behind the left or right drive wheel.

14. The method according to claim **7**, further comprising detecting whether a leg of the user is behind the left or right drive wheel.

15. The method according to claim **8**, further comprising detecting whether a leg of the user is behind the left or right drive wheel.

16. The method according to claim **9**, further comprising detecting whether a leg of the user is behind the left or right drive wheel.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,242,561 B2
APPLICATION NO. : 14/471761
DATED : January 26, 2016
INVENTOR(S) : Takahiro Katayama

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Claims

Column 22, claim 6, line 1 “left or right drive, suppressing” should read --left or right drive wheel, suppressing--.

Signed and Sealed this
Tenth Day of May, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office